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FAA Aviation Forecasts Fiscal Years 1979-1990

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16. Abstract

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In addition, this report presents the complete FAA aviation forecasting system, and describes the FAA's ongoing initiative to improve the decisionmaking utility of that system for the overall aviation community. It focuses on the FAA's interpretation of commentary received from the community, and on the agency's response to that commentary.

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FAA Aviation Forecasts Fiscal Years 1979-1990

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Washington, D.C. 20591

September 1978

75th ANNIVERSARY OF POWERED FLIGHT • 1903 - 1978 •

DEPARTMENT OF TRANSPORTATION • UNITED STATES OF AMERICA •

Preface

This Federal Aviation Administration (FAA) report contains the official FAA forecasts of domestic aviation activity for Fiscal Years 1979 through 1990. It presents forecasts of aviation activity levels at FAA towered airports, air route traffic control centers, and flight service stations, as well as forecasts of aviation activity for air carriers, air taxis, general aviation, and the military—the four major users of the National Aviation System (NAS).

In addition, this report presents the complete FAA aviation forecasting system, and describes the FAA's ongoing initiative to improve the decisionmaking utility of that system for the overall aviation community. It focuses on the FAA's interpretation of commentary received from the community, and on the agency's response to that commentary. We encourage readers to review this information, and to use it as a basis for working with the FAA in its effort to improve the decisionmaking utility of FAA aviation forecasts.

Acknowledgements

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Air Cargo—James Hines

Commuter Air Carriers—Pamela Kruzic and Harold Hanson

Military Aviation—Hugh May

Flight Services and Instrument Operations—Thomas Henry

Statistical Assistance—Janice Hartwill and Virginia Price

Text Assembly—Barbara Turner and Geraldine Bolden

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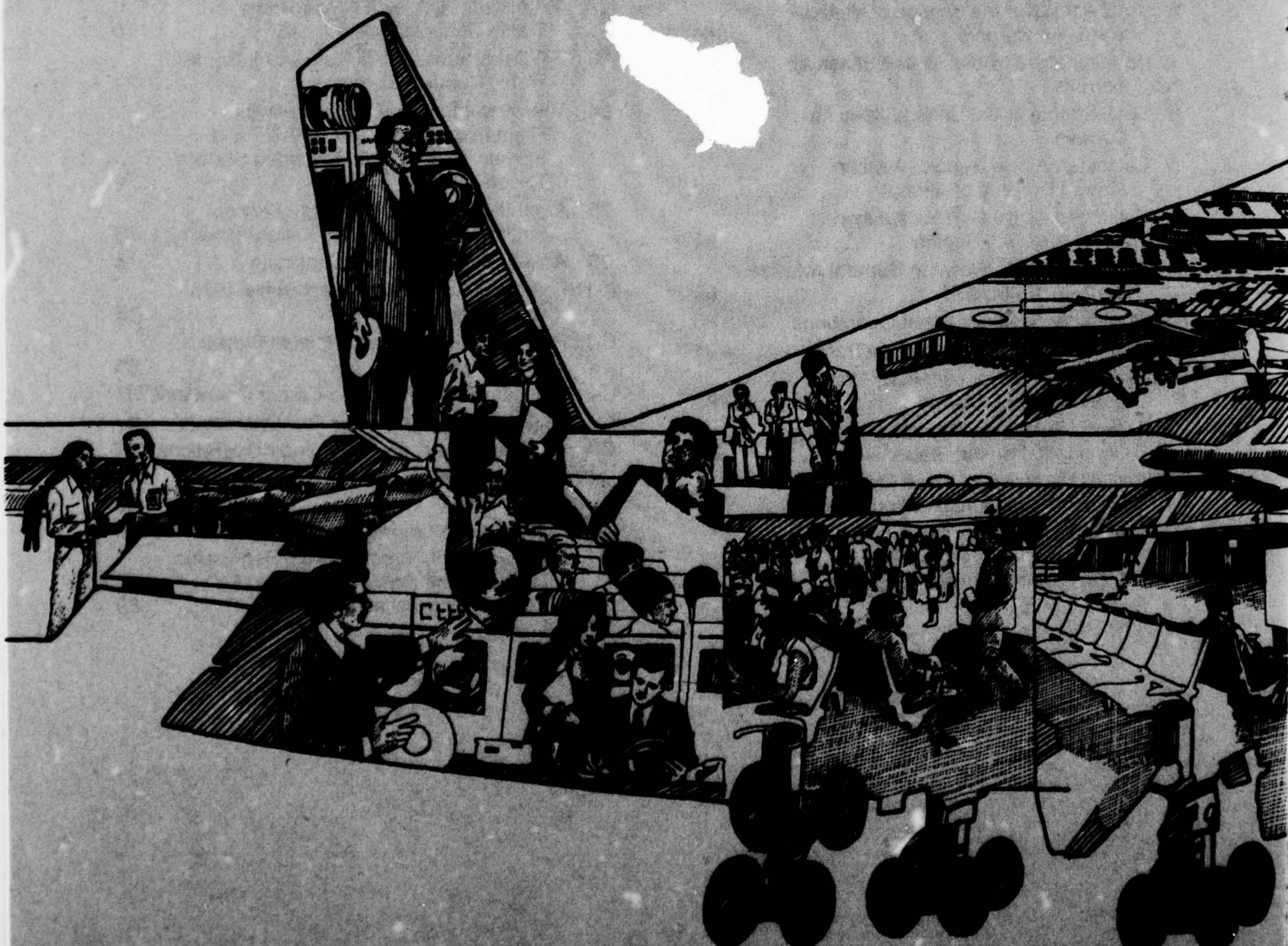
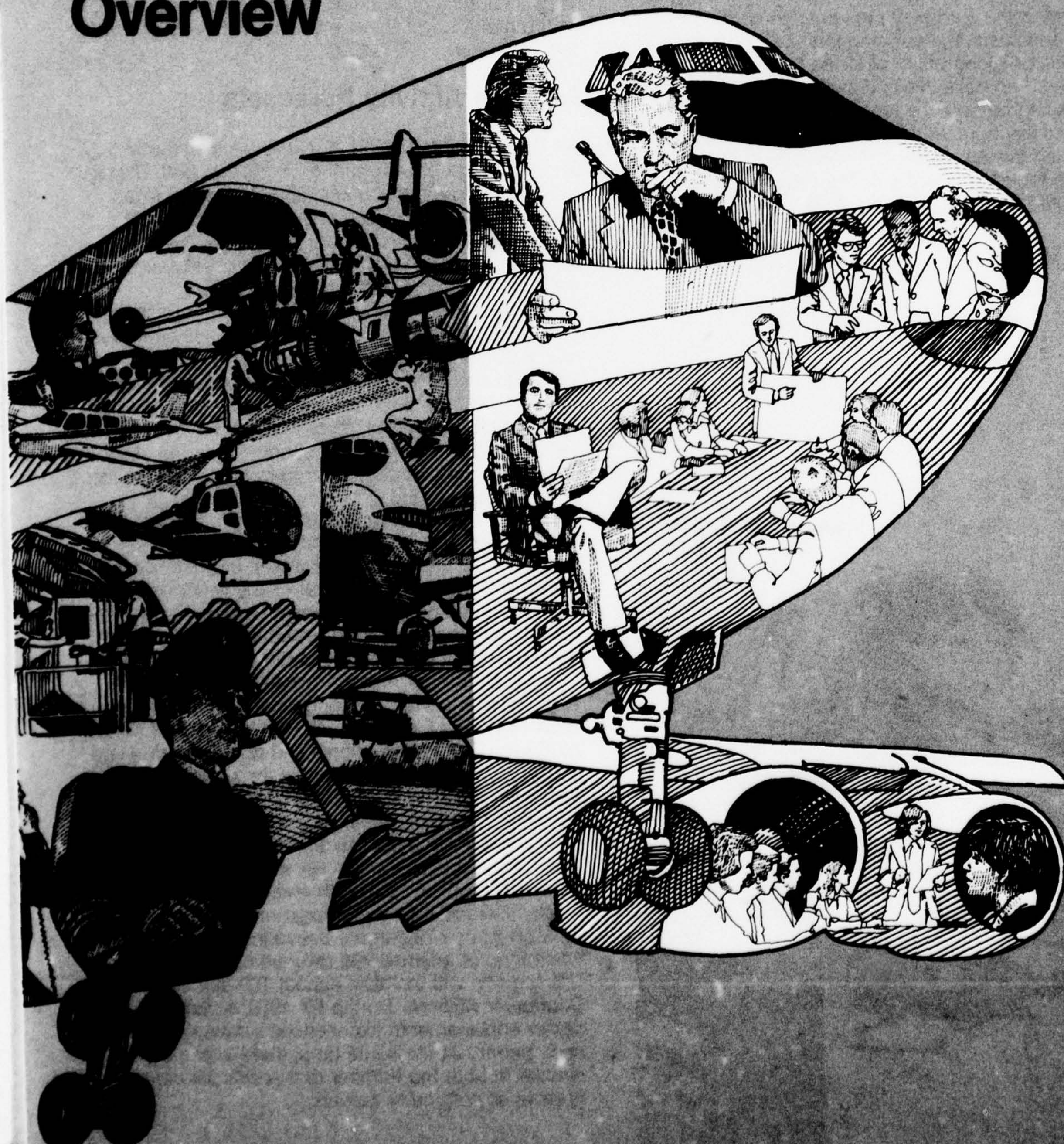
Contents

List of Figures

List of Tables



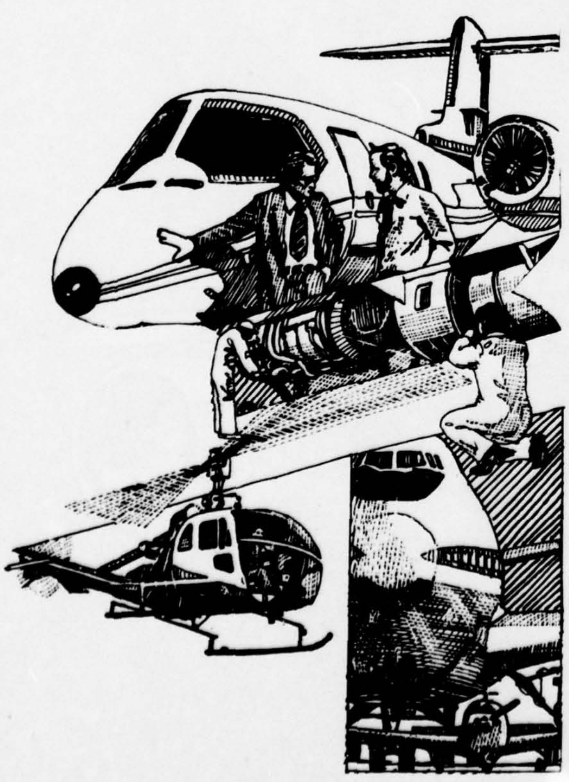
Chapter 1
Overview



The official 1978 FAA forecasts of domestic and U.S. portions of international aviation activity for Fiscal Years (FY) 1979 through 1990 are summarized below. In general, the record for 1978 shows a return to the dynamic growth that has characterized air transportation throughout most of its history.

Detailed presentations of these baseline forecasts are found in Chapter 2: *FAA Aviation Forecasts.* Other forecasts, which predict the course of aviation activity should events evolve differently from those assumed for the baseline forecast, are presented in Chapter 3: *Alternative Economic Scenarios.* Complete tables of the 1978 FAA aviation forecasts are found in Chapter 5.

Following the summary presentation of 1978 FAA aviation forecasts, the ongoing initiative to improve the decisionmaking utility of these forecasts is discussed. The objective is dissemination of information that can be used by the aviation community as a basis for working with the FAA to improve the overall forecasting system. A detailed discussion of the initiative is found in Chapter 4: *The FAA Aviation Forecasting System.*



Summary of 1978 FAA Aviation Forecasts

Table 1 presents estimates of aviation activity during 1978 and projections of activity for 1990, together with total and average annual growth for the 12-year forecast period. Table 2 presents average annual growth and total growth for the periods FY 1978 through 1983 (5-year forecast) and FY 1978 through 1990 (12-year forecast), and also reviews historical data for 1978 and the 5-year period 1973 through 1978. Thus, historical growth can be compared with projected growth over the nearer term (1978-1983) and the longer term (1978-1990).

Aviation Activity Forecasts

Air Carriers: Certificated air carriers experienced above average growth during FY 1978 in both the domestic and international sectors. This growth was caused by above average strength in the general economy and, possibly more importantly, by the lowering of fares which reduced the cost of air travel for many members of the traveling public.

The above normal increase in air carrier passengers is forecast to continue during FY 1979. However, air carrier operations are forecast to increase at a normal rate, with the larger volumes of passengers being absorbed by higher average load factors and larger capacity aircraft. Another factor that will tend to lower the growth rate in air carrier operations is the likely transfer of city pair segments from air carrier service to commuter service.

During the 1980s, air carrier traffic is forecast to grow at a slower rate than that expected for the 1977 through 1979 time period. However, both enplanements and passenger miles are expected to grow faster than the general economy. Overall, the air carrier industry is expected to experience a 5.2 percent average annual growth in total domestic scheduled revenue passenger miles between FY 1978 and FY 1990. Total enplaned passengers will increase from 262.4 million in FY 1978 to 453.9 million by FY 1990.

Air Cargo: Both international and domestic air cargo shipments will increase strongly throughout the forecast period, as a result of anticipated growth in time-sensitive cargo shipments and a favorable shift in the relative quality and cost factors between air and surface transportation modes. Growth will be concentrated in freight service, with mail increasing less rapidly. Domestic revenue cargo enplaned tons is forecast to rise 73 percent between 1978 and 1990, while tons of international revenue cargo enplaned at U.S. airports will increase almost 150 percent.

Commuter Airlines: During FY 1978, commuter air carrier enplanements experienced a robust 10.8 percent growth. At the same time, there was a slight decline in both the number of markets served and the number of commuter carriers.

This year's forecast assumes that regulatory reform, whether by legislative action or Civil Aeronautics Board (CAB) administrative policy changes, is inevitable and will have an overall positive impact on the commuter air carrier industry. However, the impending upgrading of FAA regulation Part 135, which prescribes more stringent safety standards for commuter carriers, could cause some decline in commuter activity.

The net result of more stringent safety regulations and reform of economic regulations will be more enplanements on more commuter carriers serving more markets in an even safer operating environment. If these asumptions are correct, there is a bright future ahead for the commuter air carrier industry, as reflected in the forecasts. By 1990, approximately 16 million passenger enplanements are forecast for commuter carriers in the 48 contiguous states plus Puerto Rico, up 101.2 percent from 1978.

General Aviation: General aviation flying in the short-term is expected to recover strongly from the decline in the rate of growth observed in FY 1978. In the long-term, the rate of growth of GA will decline again, primarily because of increases in fuel cost. A comparatively moderate 4.3 percent annual growth rate is forecast through 1990 for the general aviation fleet. Hours flown by general aviation are forecast to increase at a sharply lower rate than historical averages, again due to higher anticipated fuel costs.

Military Aviation: Both the number of active military aircraft and the number of hours flown will remain stable throughout the forecast period. During this time, the military proportion of the total national fleet will fall to 6 percent (10 percent currently), and its proportion of total hours flown will fall to 7 percent (11 percent currently).

Aircraft Fleet: The U.S. civil aircraft fleet now numbers approximately 189,000 airplanes. General aviation is by far the largest section, accounting for 98.7 percent of the total. In addition, the military has approximately 18,800 aircraft stationed within the United States.

The civil fleet is forecast to grow to approximately 313,800 aircraft by 1990, up 66 percent from the 1978 level. The general aviation proportion of the total fleet will remain virtually unchanged.

FAA Workload Measures

Aircraft Operations In FY 1978, total aircraft operations at airports with FAA towers remained close to the FY 1977 level of 66.7 million. Total aircraft operations are forecast to climb 50 percent by 1990. General aviation operations experienced a decline in growth during FY 1978. This decline, particularly noticeable in local operations, is attributable to bad weather, termination of veterans educational benefits, and traffic congestion.

Instrument Operations: The 3.8 percent increase in instrument operations between FY 1977 and FY 1978 was concentrated in the general aviation sector, and reflected increased use of avionics by general aviation pilots. Instrument operations are forecast to increase 59 percent between FY 1978 and FY 1990. Again, the increase will be concentrated in the general aviation sector, where the percentage of instrument operations will rise to approximately 38 percent of total operations from the current level of 31 percent. There will also be strong growth (128 percent by 1990) in air taxi instrument operations as a result of increased commuter traffic and higher utilization of avionics by air taxi operators.

IFR Aircraft Handled: FAA Air Route Traffic Control Centers (ARTCCs) handled 28.1 million Instrument Flight Rules (IFR) operations during 1978, up 8.1 percent from 1977. All sectors of the aviation industry showed gains, with general aviation growing most strongly. IFR forecasts through 1985 are essentially unchanged from last year. However, beyond 1985, the forecasts are higher owing to an expected greater increase in the number of IFR-rated general aviation pilots. Exceptionally strong growth (205 percent between FY 1978 and FY 1990) is forecast for air taxi IFR operations due to an expected surge in air taxi traffic. Overall, IFR operations are forecast to increase 62 percent between FY 1978 and FY 1990.

Flight Service: Total services in FY 1978 rose substantially (7.3 percent) over FY 1977, resuming the historical upward trend that was interrupted briefly during 1976. Between the present and 1990, total flight services are forecast to experience the highest growth of the three major FAA operations services, rising 104 percent. In FY 1990, pilot briefs are expected to be 132 percent over FY 1978, while flight plans originated are expected to be up by 105 percent. In contrast, the number of aircraft contacted will be at about the FY 1978 level, indicating the use of other FAA services by pilots.

Table 1
Aviation Activity Forecasts

	1978 Estimate	1990 Forecast	Average Annual Growth Rates (percent)	Growth (percent)
Aviation Activity Forecast				
Air Carriers				
Revenue Passenger Enplanements (Millions)	262.4	453.9	4.7	73.0
Revenue Passenger Miles (Billions)	212.5	394.1	5.3	85.5
Air Cargo				
Revenue Tons Enplaned (Thousands)	4,936	9,380	5.5	90.0
Revenue Ton Miles (Millions)	11,691	27,856	7.5	138.3
General Aviation				
Fleet (Thousands)	186.6	310.8	4.3	66.6
Hours Flown (Millions)	38.6	67.4	4.8	74.6
Commuter Carriers (Millions)				
Operations	3.1	5.6	5.1	80.6
Revenue Passenger Enplanements	8.2	16.5	6.0	101.2
Revenue Passenger Miles	941.6	2,081.5	6.8	121.1
Military				
Fleet	18,801	18,721	− 0.04	− 0.4
Hours Flown (Thousands)	5,487	5,697	0.31	3.8
FAA Workload				
Aircraft Operations (Millions)				
Air Carrier	10.1	12.9	2.1	27.7
Air Taxi & Commuter	3.5	8.4	7.6	140.0
General Aviation	50.6	76.4	3.5	51.0
Military	2.5	2.5	-	-
Total	66.7	100.2	3.5	50.2
Instrument Operations (Millions)				
Air Carrier	10.5	13.3	2.0	26.7
Air Taxi & Commuter	2.9	6.6	7.1	127.6
General Aviation	15.7	28.5	5.1	81.5
Military	3.6	3.6	-	-
Total	32.7	52.0	3.9	59.0
IFR Aircraft Handled (Millions)				
Air Carrier	13.6	17.4	2.1	27.9
Air Taxi & Commuter	1.9	5.8	9.8	205.3
General Aviation	8.2	18.0	6.8	119.5
Military	4.4	4.4	-	-
Total	28.1	45.6	4.1	62.3
Flight Services (Millions)				
Pilot Briefs	18.2	42.3	7.3	132.4
Flight Plans Originated	9.4	19.3	6.2	105.3
Aircraft Contacted	10.6	11.3	0.5	6.6
Total	65.8	134.5	6.1	104.4

Table 2 Summary of 1978 FAA Aviation Forecasts

Aviation Activity Forecasts

Aviation Activity	Average Annual Growth Rate (Percent) Historical 1973-1978	Historical 1978 *	Forecast 1978-1983	Forecast 1978-1990	Total Growth (Percent) Historical 1973-1978	Forecast 1978-1983	Forecast 1978-1990
Air Carriers							
Revenue Passenger Enplanements	5.9	12.0	5.3	4.7	33.0	29.3	73.0
Revenue Passenger Miles	6.1	13.2	5.9	5.3	34.6	32.8	85.5
General Aviation							
Total Aircraft	5.2	4.6	5.2	4.3	28.7	28.8	66.6
Hours Flown	6.3	5.2	5.7	4.8	35.4	32.2	74.6
Air Cargo							
Revenue Tons Enplaned	-	7.2	5.5	5.5	-	30.9	90.0
Revenue Ton-Miles	-	8.0	7.5	7.5	-	43.8	138.3
Commuter Carriers							
Operations	11.5	10.7	7.3	5.1	72.2	41.9	80.6
Enplanements	10.4	10.8	7.4	6.0	64.0	42.7	101.2
Revenue Passenger Miles	14.1	12.6	8.3	6.8	93.2	48.9	121.1

FAA Workload Measures

FAA Operations	Average Annual Growth Rate (Percent) Historical 1973-1978	Historical 1978 *	Forecast 1978-1983	Forecast 1978-1990	Total Growth (Percent) Historical 1973-1978	Forecast 1978-1983	Forecast 1978-1990
Tower Operations							
Air Carrier	.6	3.1	2.5	2.1	3.1	12.9	27.7
Air Taxi & Commuter	10.7	6.1	10.3	7.6	66.7	62.9	140.0
General Aviation	5.5	-	5.5	3.5	30.8	30.6	51.0
Military	-	-	-	-	-	-	-
Total	4.8	-	5.1	3.5	23.8	28.2	50.2
Instrument Operations							
Air Carrier	1.4	5.0	2.2	2.0	7.1	11.4	26.7
Air Taxi & Commuter	21.4	11.5	8.2	7.1	163.6	48.3	127.6
General Aviation	16.2	3.3	6.0	5.1	112.2	33.6	81.5
Military	-	-	-	-	-	-	-
Total	7.8	3.8	4.4	3.9	45.3	24.6	59.0
IFR Aircraft Handled							
Air Carrier	1.5	4.6	2.3	2.1	7.9	11.8	27.9
Air Taxi & Commuter	16.1	18.8	14.3	9.8	111.1	94.7	205.3
General Aviation	12.3	18.8	8.1	6.8	78.3	47.6	119.5
Military	-	-	-	-	-	-	-
Total	4.3	8.1	4.7	4.1	23.3	26.0	62.3
Flight Services							
Pilot Briefs	4.4	7.7	10.2	7.3	23.8	62.6	132.4
Flight Plans Originated	5.5	8.0	8.5	6.2	30.6	50.0	105.3
Aircraft Contacted	1.4	3.9	2.3	0.5	7.1	12.3	6.6
Total	4.2	7.3	8.6	6.1	22.5	50.9	104.4

* 12 months ending September 30,1978 over 1977, based on preliminary data

The FAA Forecasting Initiative

The FAA's Office of Aviation Policy is in the second year of an initiative to strengthen the utility of its aviation forecasts for managers and planners throughout the aviation industry. The initiative began in 1977 with a series of seminars and consultations with different segments of the aviation community, including regional, state, and local transportation authorities, aircraft operators and equipment manufacturers, as well as individuals with strong collateral interests such as academic and investment specialists. Each event in this series focused on a specific area of aviation planning and forecasting, and each attempted to provide a forum for frank and open exchange between FAA forecasters and the users of aviation forecasts.

Conclusions from this series of seminars, consultations, and meetings were summarized in last year's Aviation Forecast Report #FAA-AVP-77-32, and were presented for discussion at the Third Annual FAA Aviation Forecast Conference held in December 1977. Very concisely, it is the FAA's perception that the aviation community is most concerned with the following four issues:

User-Oriented Specificity. Although the computational processes of the FAA forecasts include factors of vital interest to planners throughout the aviation community, the outputs generally express the parameters directly required by the FAA. Commentators stress that FAA forecast output should be reformatted to supply information required by the entire aviation community, when feasible. Geographic disaggregation, traffic identification, and temporal disaggregation were identified as important areas requiring greater specificity.

FAA Forecasting Role. A strongly expressed opinion was that FAA forecasting should generally be complementary to the work of others, not a duplication of or a replacement for such efforts. Closely allied with this is concern about the structure and timing of the FAA forecast-generating process. If FAA forecasts are to be of maximum benefit to the aviation community, they must be designed to supply the specific information required by various planning elements of the community; they must be disseminated in synchronism with the forecasting, budgeting, and planning cycles of regional, state, and local authorities; and there must be an exchange of forecast and base data as the forecasting process moves forward each year so that final products incorporate the knowledge and perception of all concerned parties.

Aggregation. A basic criticism of FAA forecasting is the approach by which local forecasts (such as those for terminal areas, hubs, and flight service stations) are developed by disaggregating national forecast totals. While satisfying the FAA need for aggregated traffic data, these "disaggregated" local forecasts cannot be related directly to locally derived forecasts and, therefore, cannot be used to pinpoint structural variations when the forecasts differ.

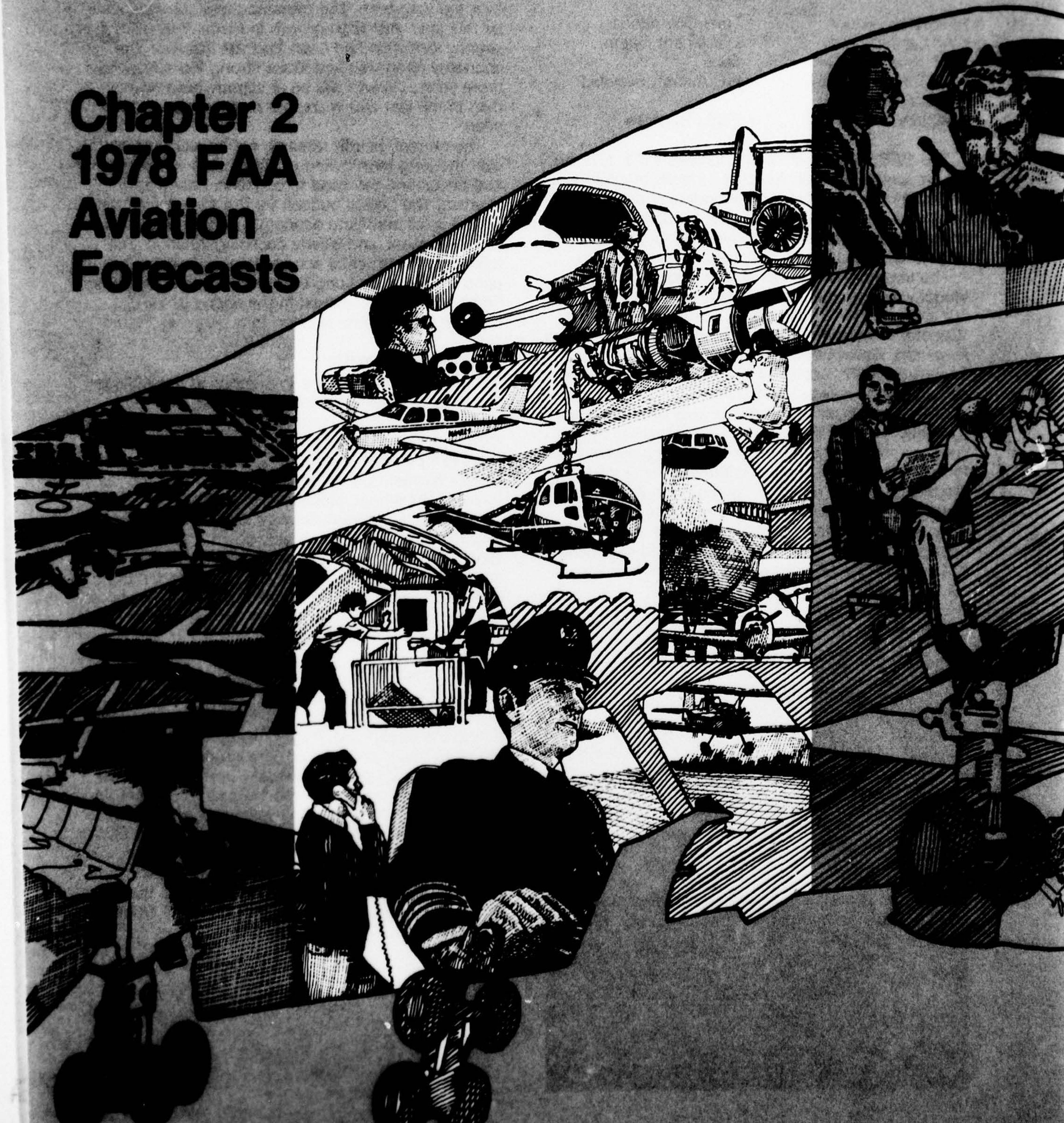
Event Impact Analysis. The aviation community expressed concern over the limitations to decisionmaking imposed by forecasts based on a single, "most likely" combination of future events. The development of methods for assigning probabilities or confidence intervals to predicted parameters was suggested, as was the development of forecasts which explore growth patterns that would result should a particular major event occur, such as an oil embargo or regulatory reform. Countering this need, however, is the fundamental charter that FAA forecasting provide an unambiguous basis for budget, personnel, and resource decisions.

The concensus from all commentary received to date from a wide cross-section of the aviation community indicates broad support for the development of additional aviation forecasts and data-gathering efforts by the FAA on the one hand, while, on the other hand, expressing concern that the FAA may be stepping too far into jurisdictional areas in which other authorities have direct responsibility. To accommodate these somewhat contradictory needs, the FAA initiative to improve the decisionmaking utility of aviation forecasts is now progressing forward in two directions simultaneously. First the agency is continuing to sponsor research projects that are directed at deficiencies in the forecasting system as perceived by the aviation community. Generally, these projects focus on the inadequate data base of general aviation or fulfill "one-time" or periodic forecasting needs. Two examples are a "Fixed-Base Operators Study" that is generating new planning information for the general aviation industry, and an "Atlantic Coast Basin Forecast" that deals with the new and increasingly busy air carrier routes across the Atlantic.

Secondly, and perhaps more fundamentally, the FAA's Office of Aviation Policy is reshaping the process through which it works with other members of the forecasting community. New procedures and schedules are being implemented that actively involve regional, state, and local planning authorities in the generation of aviation forecasts.

For the remainder of this year, the FAA will be working on its forecasting system and reviewing its work with the aviation industry through a series of seminars and special consultations. At this year's Aviation Forecast Conference, the agency hopes to have some of the new forecasting models running, output from its new data-gathering efforts, and a yearly schedule for interaction with the aviation community in the preparation of future forecasts. By the end of the forecasting initiative, FAA forecasts should be more useful in support of decisionmaking by all levels and segments of aviation planning, and a rational working procedure should be in place that will achieve an optimum degree of cooperation and interaction between FAA forecasters and other members of the aviation community.

Chapter 2
1978 FAA Aviation Forecasts



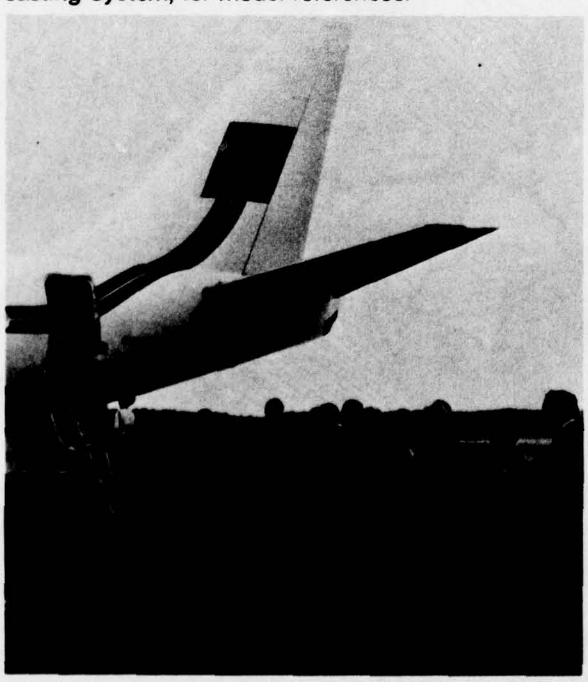
The 1978 FAA aviation forecasts are presented in this chapter. Two categories of forecasts are provided, one measuring overall activity of the various aviation user groups and the other dealing with operational services provided by the FAA.

Aviation Activity	**FAA Operational Services**
• General Aviation	• Total Operations
• Air Carriers	• Instrument Operations
• Air Taxi and Commuter Airlines	• IFR Aircraft Handled
• Military Aviation	• Flight Services

The 1978 status and 12-year forecasts (FY 1979-90) are presented for each forecast variable. In addition, a brief sketch is given of the methodology and assumptions employed in each case. The fundamental socioeconomic assumptions underlying all forecasts are also summarized in this chapter.

The structure of the General Aviation Forecast Model was not changed from last year's presentation. For a description of the model see Appendix C: "General Aviation Forecasting Model" in *FAA Aviation Forecasts Fiscal Years 1978-1989*, FAA-AVP-77-32, September 1977. Copies of the 1978 coefficients are available upon request from FAA.

A new macro air carrier model was developed with a slightly different set of variables to improve the specifications of the model. In addition, a sub-model for international passenger traffic was developed. A discussion of this model is presented in Appendix B. Detailed descriptions of the commuter model and military extrapolation procedures remain virtually unchanged from last year and are presented in separate documents. See Chapter 4, The FAA Aviation Forecasting System, for model references.



Baseline Forecast: Socioeconomic Assumptions

In 1976 and 1977, the economic outlook was characterized by short-term optimism, but greater caution over the long term. The overall outlook remains similar this year. Although growth in Fiscal Year 1978 was slightly less than had been forecast last year, the economy fared well and looks strong for at least two more years. Growth will be at slightly lower levels than in the last two years, but no recession is foreseen.

The current growth rates do not appear sustainable over the long term owing to anticipated increases in fuel prices and the need to conserve energy resources. The overall outlook for the 12-year forecast period is for moderate economic growth, declining unemployment, and slowly declining inflation. The following fundamental economic assumptions, based upon the Wharton Long-Term Industry and Economic Forecasting Model issued in the spring of 1978, underlie the baseline aviation forecasts (see Figure 1).

Economic Growth

The economic recovery that began in late 1975 is assumed to continue through 1979, but with more moderate growth in Gross National Product (GNP) in 1978 and 1979 (4.3 percent) than in the previous two years (5.4 percent). Over the forecast period, annual growth for real GNP is expected to average approximately 3.3 percent, reduced slightly from the 3.5 percent forecast last year. Growth will be the greatest over the next two years. A slowdown is anticipated in 1981-82, followed by a series of years in which GNP growth is 3 percent or better. This is less than the historical average due to the recent decline in population and productivity growth that are expected to continue.

Employment

Slower increases in employment are anticipated than in recent years, which saw strong growth mainly due to the entrance of large numbers of women into the labor force. Employment growth rates are expected to be 2.4 percent annually over the next two years, decreasing to between 1.9 and 1.5 percent annually during the 1980s. An average growth rate of slightly under 1.6 percent is expected between 1980 and 1990, principally because the number of entrants into the labor force will be expanding more slowly. Unemployment rates are forecast to decline steadily during the period, reaching approximately 4 percent by 1990.

Inflation

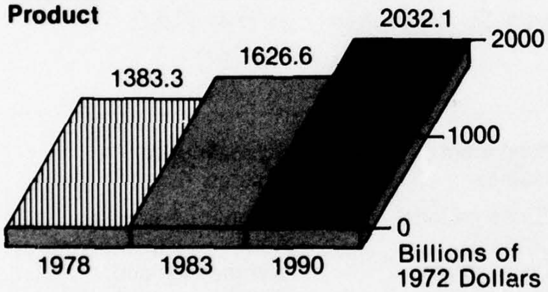
As measured by the consumer price index, inflation rates of 6.7 and 7.3 percent are assumed for 1979 and 1980, followed by slowly declining inflation rates averaging 6.0 percent through 1990. The average annual inflation rate now anticipated for the forecast period is 6.2 percent, higher than the 5.7 percent forecast last year.

Consumer Spending

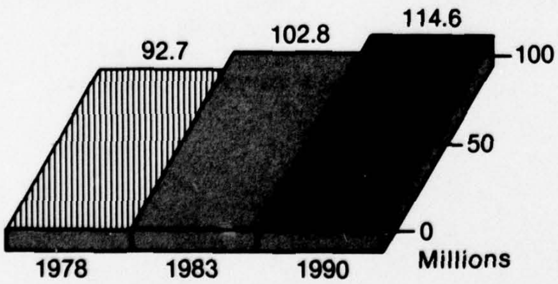
The continuing increase in disposable personal income anticipated throughout the forecast period will encourage consumer spending. However, personal consumption of services is not expected to increase as rapidly as GNP. Consumption patterns are expected to shift, with a greater proportion of disposable income being spent on fuel and fuel-efficient durable goods. As a result, the use of aviation services would weaken somewhat from past trends in relation to GNP growth; however, growth in aviation demand is still expected to exceed GNP growth.

Figure 1. Economic Assumptions Underlying Baseline Fiscal Year 1978—1990 Aviation Forecasts

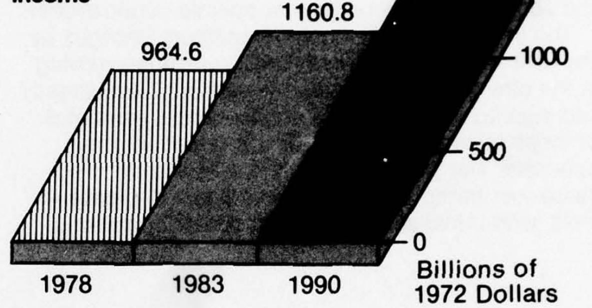
Gross National Product



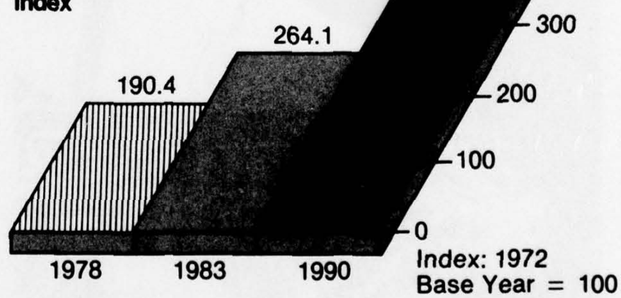
Employment



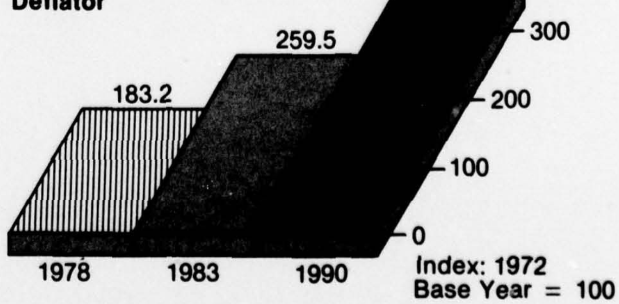
Disposable Personal Income



Consumer Price Index



Oil & Gas Deflator



Fuel

Fuel costs will rise 6.2 percent annually throughout the forecast period as a result of price increases by domestic oil producers and by the Organization of Petroleum Exporting Countries (OPEC). This projection does not include increases that might occur if additional domestic taxes were imposed on aviation fuel. The baseline forecast assumes that fuel usage will not be restricted by forces other than price.

Regulatory Reform

Proposed regulatory reform now in the legislative process is designed to strengthen competitive market forces within the air carrier industry. Entry and expansion into existing and new markets would be facilitated. Proposed regulatory reform would also provide carriers with greater discretion in fare-setting, encourage air commuter service to small communities, and allow commuter carriers to operate larger aircraft.

The impacts of the ongoing regulatory changes by the Civil Aeronautics Board (CAB), which are moving in the direction of anticipated legislation, have already had significant effect. As a consequence, estimates of these impacts have been incorporated into the forecasts. The principal effects are an increase in passenger traffic and load factors and a decrease in yield, with minimal effects on air carrier operations.

Aviation Activity Forecasts

General Aviation

Methodology and Assumptions

The basic forecasts of general aviation activity are derived from the FAA's General Aviation Forecast Model, an econometric model that relates measures of aviation activity to economic and demographic variables. The independent exogenous variables, which come primarily from the Wharton Econometric Forecasting Associates Annual Model, and the measures of aviation activity used in the General Aviation Forecast Model are summarized in Figure 2. The fundamental assumptions underlying this approach are that the various measures of aviation activity are related to the level of economic activity and that the various activity measures are dependent on one another.

Activity measures not estimated by this model are generated from time-series analyses. For example, forecasts of average number of hours flown per aircraft per year are developed from historical trends. These factors are then applied to the forecasts of the general aviation fleet to estimate the number of hours flown.

Figure 2. Variables in the FAA General Aviation Econometric Model

Independent Variables

- Gross national product.
- Civilians employed.
- Plant and equipment expenditures by the aerospace industry.
- General aviation cost index.

Derived Activity Measures

- Number of aircraft.
- Active private, student, commercial, and instrument-rated pilots.
- Itinerant and local operations.
- IFR departures and over flights.
- IFR and VFR flight plans filed.
- Pilot briefs.
- Aircraft contacted.
- Instrument operations.

General

With emphasis on conservation of resources, coupled with operating costs that are expected to rise more rapidly than the rise in prices attributable to inflation, private flying for pleasure is not expected to increase as rapidly as in the past. The main stimulus to general aviation should come from business flying. Many companies, particularly those located at the edge of urban areas or in the country, may find that flying managerial staff and engineering and marketing personnel in company planes makes economic sense.

During the 1980s, a number of new general aviation airports are expected to open. Typically, these airports will be located at the edge of urban areas and many will serve as reliever airports, thus reducing traffic at the major hubs. They will also tend to serve as major maintenance and training facilities for geographic regions. The number of general aviation airports with towers and instrument landing systems should grow to match the availability of avionics equipment and increased traffic volumes. In some communities, however, the need for land for airports may be deemed less important than other needs, and airports may be closed or moved to locations where land is cheaper. Regional shifts of population may also contribute to change. Increases in the number of towered airports (usually upgrading of existing fields) are expected in the Southern, Western, and Northwest Regions. Some towers may be decommissioned, if warranted by reduced demand for their services.

In its efforts to improve the safety of the National Aviation System, the Federal Aviation Administration can be expected to encourage general aviation pilots to upgrade their use of avionics equipment. This, coupled with intensified training and educational programs, should result in a reduction of the general aviation fatality rate.

The 1978 level of general aviation operations at airports with air traffic control service is estimated to have declined slightly from 1977 levels. This decline, particularly noticeable in local operations, is attributable to:

- Bad flying weather, especially in the Western Region where an estimated 15 percent of GA aircraft are registered.
- The termination in August 1977 of all educational benefits to veterans who were discharged between 1954 and August 31, 1967, which resulted in a limitation in local training flights. Under the current program (VAR 11042.CS) the 10-year limit on educational benefits also applies to Vietnam and post-Vietnam veterans.
- Traffic congestion and service constraints at some towered airports which may have caused GA pilots to increase their use of nontowered airports.

During the forecast period, the growth in the pilot population, business flying, and the number of towered airports will combine to increase the number of itinerant general aviation operations at towered airports from 28.1 million in 1978 to 43.2 million in 1990. General aviation local operations are expected to increase from 22.5 million operations in 1978 to 33.2 million in 1990.

Fleet Size

Status: There were 186,600 active aircraft in the general aviation fleet as of January 1, 1978, up 4.7 percent from the preceding year. The distribution of the fleet by FAA region is shown in Figure 3.

Forecast: General aviation airframe manufacturers will continue producing aircraft at a steady pace. Based on the past relationships between employment, expenditures in the aircraft industry, and the number of active GA aircraft, the fleet is forecast to rise from 186,600 in 1978 to 310,800 in 1990. This represents a 66.6 percent increase during the 1978-1990 forecast period, or an annual average increase of 4.3 percent. By comparison, the average growth rate was 5.2 percent during the 1973-78 period. In conjunction with the continued increase in the fleet during the 1978-1990 period, there should be gradual product improvements encouraging more people to fly, particularly in smaller aircraft that will continue to dominate the market (see Figure 4).

Fleet Composition

Status: Single-engine piston aircraft totaled 151,200 on January 1, 1978, representing approximately 81 percent of the general aviation fleet. The remaining 19 percent was distributed among multiengine piston aircraft (22,400), turbine aircraft (4,900), rotorcraft (4,700), and balloons, dirigibles, and gliders (3,400).

Forecast: Based on past trends and relative market shares, the number of single-engine piston aircraft is expected to increase to 245,000 by 1990 and to account for 78.8 percent of the fleet. In 1990, multiengine piston aircraft will represent 12.5 percent of the fleet, as compared to 12.0 percent in 1978. The higher relative growth rate in multiengine piston and turbine aircraft, compared with single-engine piston aircraft, points to increased sophistication among general aviation pilots.

Hours Flown

Status: Based on preliminary data, hours flown in general aviation aircraft reached 38.6 million in 1978, up from 36.7 million in 1977. The 5.2 percent increase for 1978 was higher than the 4.6 percent growth in 1977.

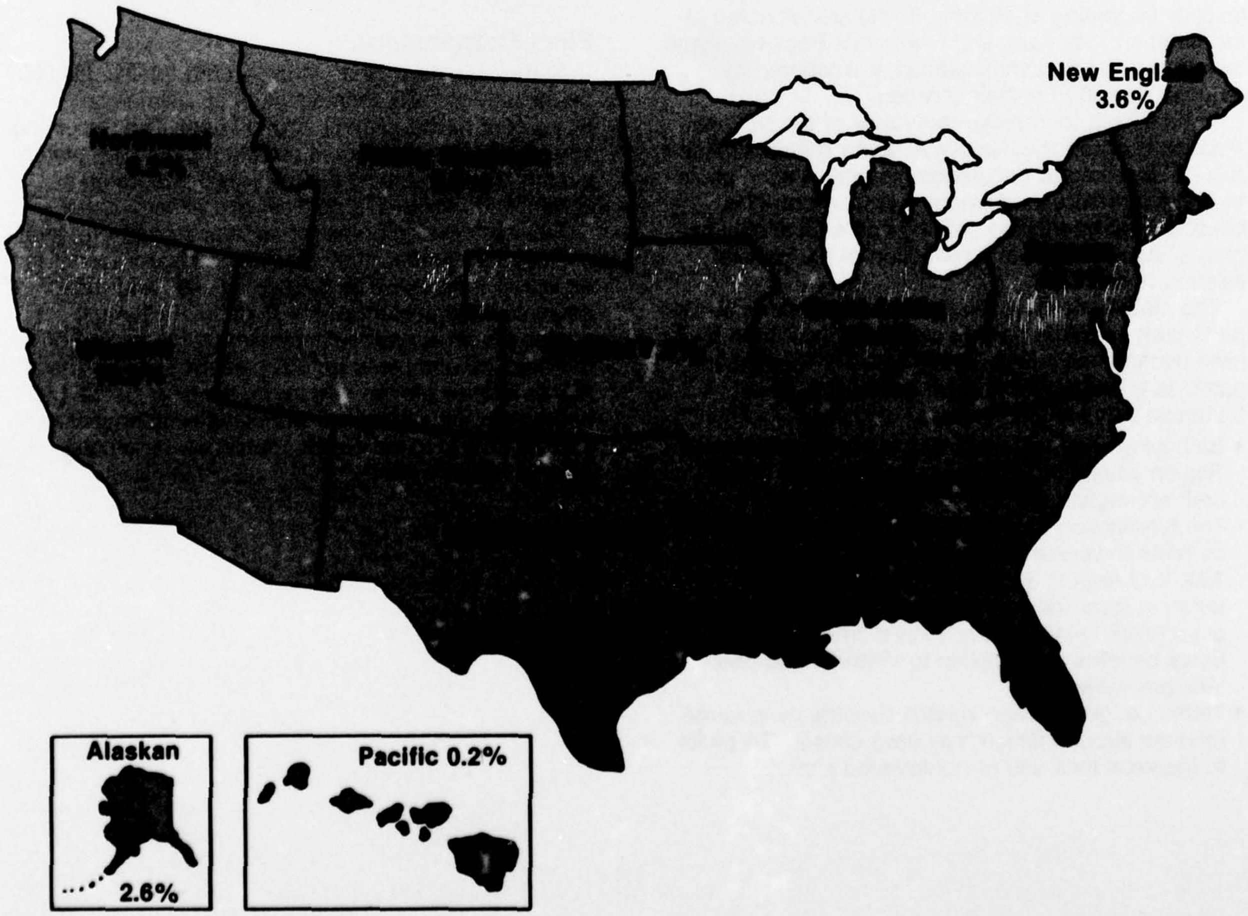
Forecast: The number of hours flown is forecast to increase to 67.4 million by 1990, which is 74.6 percent higher than the 1978 total. As shown in Figure 4, this translates to a 4.8 percent average annual growth rate, down sharply from historical values (the average annual increase was 6.3 percent from 1973 through 1978). The lower growth forecast is due primarily to higher anticipated fuel costs for general aviation and is consistent with recent trends in aircraft utilization rate.

Active Pilots

Status: On January 1, 1978, there were 783,900 active pilots, up 5.3 percent from the 744,200 reported one year earlier. The number of instrument-rated pilots totaled 226,300, an increase of 14,900 over the previous year (see Figure 5).

Forecast: The number of general aviation pilots is expected to increase to 1,155,800 by 1990. This represents a 47.0 percent increase during the forecast period. The number of private pilots is forecast to increase as interest in flying grows among a population that will be slightly older, will have fewer children, and will have a steadily rising disposable personal income. The number of student pilots is forecast to rise slowly from approximately 203,500 in 1978 to a peak of 231,800 in 1985, and to decline steadily thereafter,

Figure 3. Distribution of General Aviation Aircraft by FAA Region, January 1, 1978



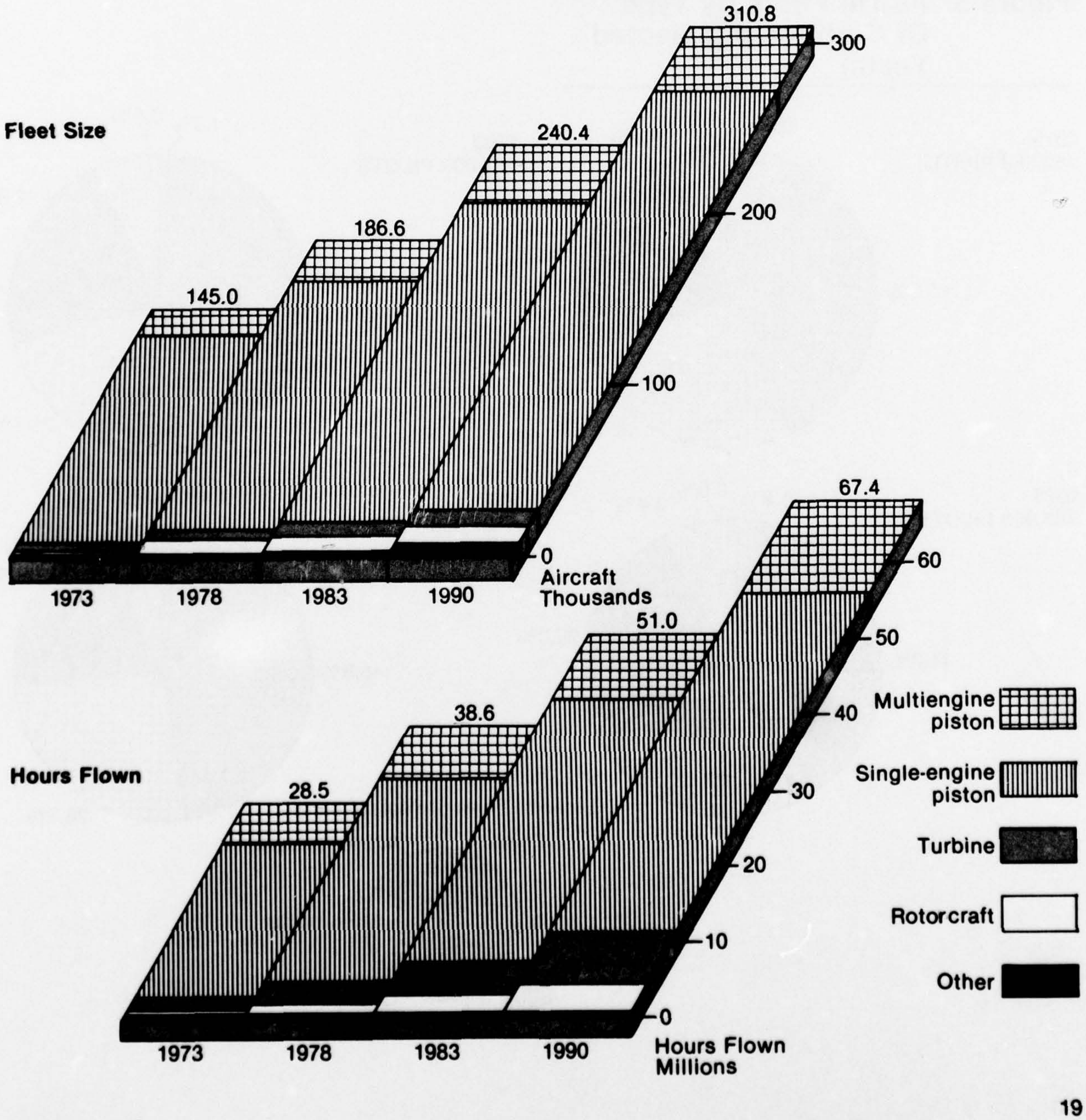
going back to 225,000 in 1990. Since the number of pilots who will give up their license are fewer than the number of new pilots trained, the private pilot population will increase steadily during the forecast period, rising from 327,400 in 1978 to 529,600 in 1990. Despite this increase in the number of pilots, pleasure flights by individuals are expected to diminish in importance as costs continue to increase and as conditions become more and more crowded at those urban GA airports that continue operations.

Air Carriers

An air carrier is defined by the FAA as "any operator of large aircraft that transports passengers or cargo for hire." As seen in Figure 6, the FAA classifies the air carrier industry into eight groupings. At present, there are 78 carriers operating 2,495 aircraft. The operations at FAA towered airports and the aircraft handled by ARTCCs of these 78 carriers, along with foreign air carriers serving FAA towered airports, are the subject of this part of the forecast.

Figure 4. General Aviation Fleet Size and Hours Flown

FY 1978 Status		FY 1978-90 Forecast Average Annual Growth Rate	
Fleet:	+4.7% Growth	Fleet:	4.3%
Hours:	+5.2% Growth	Hours:	4.6%



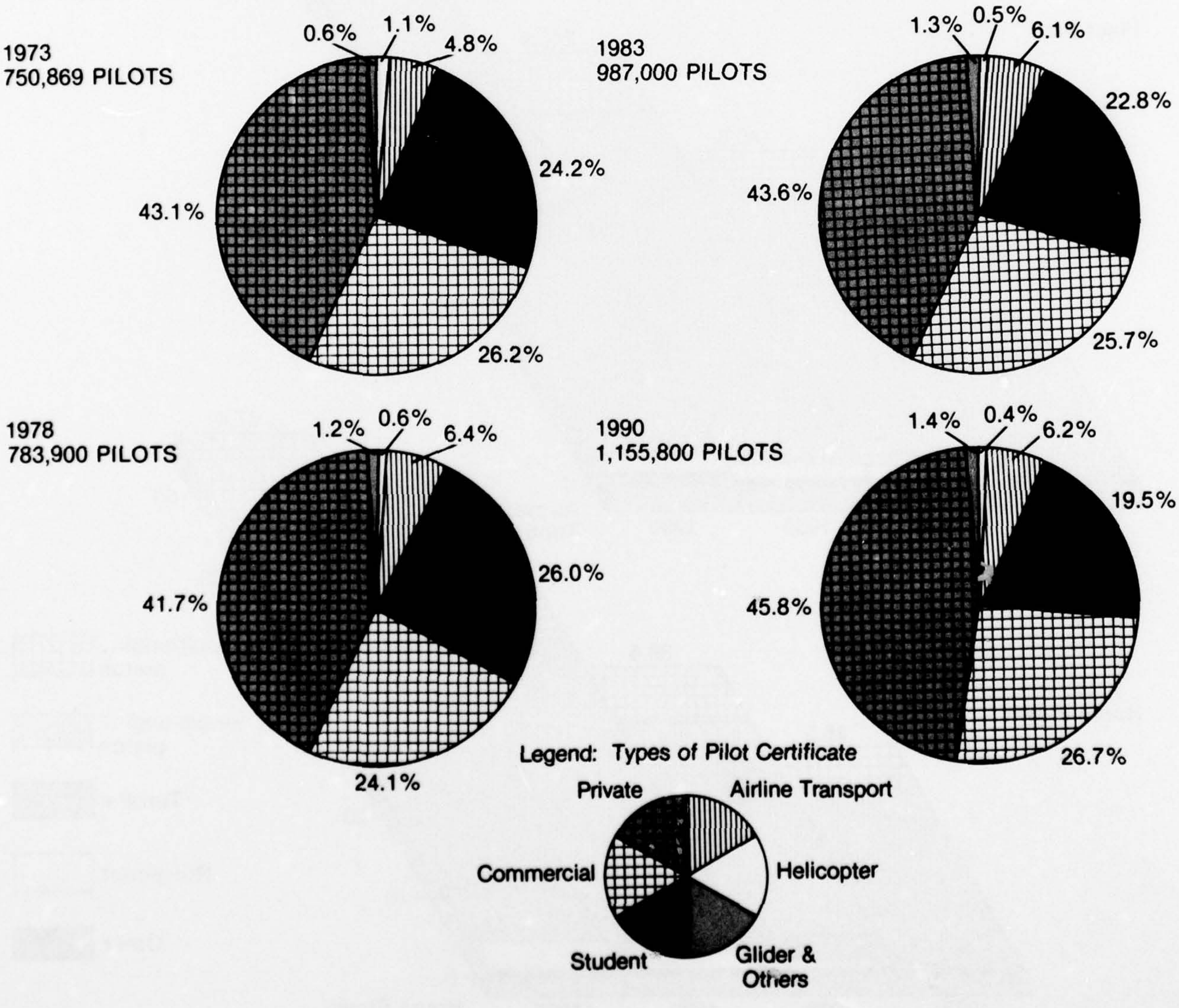
Methodology And Assumptions

Two techniques are employed to forecast the level of air carrier aircraft activity and the anticipated workload at FAA facilities: The macro air carrier forecasting model and the micro method. Forecasts from the two methods are compared and adjusted to achieve consistency.

Macro Air Carrier Forecasting Model: Air carrier demand forecasts of revenue passenger miles (RPMs) and enplanements (ENPs) are generated using an econometric forecasting model derived from historical relationships between various measures of economic activity and air carrier demand. The economic variables used in this model are summarized in Figure 7. The forecasts of operating characteristics used in the model (see Figure 8) are based on time-series analysis, with adjustments made for changes in costs and fares. When costs increase faster than fares, for example, airline profitability requires an increase in load-factor, seating density, or both. Similarly, continuing growth in aircraft size is reflected in the increasing average seating capacity used in the model.

Generally, the macro model shows that demand falls as growth in the general economy decreases and unemployment increases, and that demand rises with personal income and as the cost of owning and

Figure 5. Active Pilots By Type Of Certificate (Selected Years)



operating a car increases. A basic modeling assumption is that historical relationships among these variables will continue into the future. For a more detailed discussion of this model, refer to Appendix B of this report.

The macro model also forecasts towered aircraft operations for the total air carrier industry. Forecasts of passenger traffic and the industry's operating behavior form the basis for this model. The variables used and associated assumptions are as shown in Figure 8.

Figure 6. Air Carrier Groups

	No. of Carriers	Fleet Size
Trunk	11	1,706
Local Service	18	491
All Cargo	3	36
Supplemental	6	77
Helicopter	1	3
Intra-State	5	60
Contract	18	101
Travel Clubs	16	21
Total	78	2,495

Figure 7. Exogenous Variables Employed In The FAA Macro Air Carrier Forecasting Model

Economic Variable	Function
• Disposable Personal Income	• Indicates the real purchasing power available to be spent on consumer goods
• Unemployment Rate	• Reflects the negative psychological impact of a high unemployment rate
• Consumer Price Index	• Deflator for yield and price of private transportation
• Deflator for Oil and Gas	• Represents the relative price of oil and gas products and is used to determine yield
• Price Index of Private Transportation	• Represents the price of an alternative good, namely driving an automobile
• Index of the Wage Rate	• Used along with the price of oil and gas to determine yield

Figure 8. Variables and Assumptions Used in the FAA Macro Air Carrier Forecasting Model

Variable	Assumption
• Revenue passenger miles	•The economic assumptions indicate RPMs will increase with a rise in disposable income and the cost of owning, operating and maintaining a car. Increases in yield or unemployment have negative effects on RPMs.
• Average passenger load-factor	• Load factors will fluctuate between 56 and 60 percent through the mid 1980s and then stabilize at 60 percent for the remainder of the forecast period.
• Average seating capacity	• Average seating capacity will increase by about 4 seats per year as air carriers attempt to reduce the cost per seat-mile by purchasing more wide-body aircraft and adding seats to the existing fleet.
• Average stage-length	• Average stage-length will increase by about 3 miles per year.

Micro Air Carrier Forecasting: The micro model utilizes individual forecasts for each carrier in the industry as its basis. This model is used to forecast fleet size, hours and miles flown, and in conjunction with the macro model, to forecast operations. The driving variable is the number of aircraft, by type, that each carrier has on hand and on order. Estimates for future types and numbers are made after discussions with many air carriers and with all major domestic aircraft manufacturers. Estimates are made of the number of additional aircraft orders, beyond those announced publicly, that will be required to meet anticipated traffic growth, provide for retirement of aircraft, and allow each individual airline to maintain a competitive position with other airlines. Judgment is used to provide the basis for projecting the forecasts beyond the years for which information is available. Service patterns and frequencies of service are also forecast in general terms after discussions with members of the industry. The micro variables used and associated assumptions are described in Figure 9.

Status And Forecast

General

Demand for air transportation is expected to continue to grow faster than GNP and disposable personal income, but at a more moderate rate than in the past. It is anticipated that rising prices of essential resources, particularly fuel, will create problems for all areas of transportation in the early 1980s.

Owing to regulatory reform, trunk and local service carriers can be expected to abandon service at those smaller communities where demand is too limited to be profitable for the larger size aircraft used by these carriers. Service to these cities will be taken over by air commuter and air taxi operators. Continually rising fuel costs and capacity limits of airports will encourage air carriers to accommodate growth through increases in load factors and by using aircraft with larger seating capacities.

Technological developments in aviation are expected to improve operating economics and fuel efficiency and to reduce noise. A new U.S. built, energy-efficient, two-engine, wide-body airplane should become operational in the early-1980s, and new 2-engine standard-body jets should become operational in the early and mid-1980s. Manufacturers will continue to introduce stretch versions of previous models as airlines seek increased capacity from proven configurations. Supersonic flight will not be introduced into service between domestic points because of environmental concerns and high energy costs.

Improvements in aircraft technology should help slow the growth in operating costs. For example, newer aircraft may increasingly substitute composite materials, first for secondary and then for primary structures, to reduce weight and thereby increase fuel efficiency. However, these technological improvements will not be sufficient in themselves to offset increases in labor, capital investment, and other costs.

Figure 9. Variables and Assumptions Employed in the FAA Micro Air Carrier Forecasts

Variable	Assumptions
	(Based on Discussions with Industry Members)
• Aircraft Type *Two-engine	• Continued introduction of DC-9 and 737 (both new and purchased from trunk carriers) into local service carrier fleets. • Replacement of remaining turboprops with twin engine standard-body aircraft in late 1970s. • Introduction of a new wide-body aircraft in early 1980s.
*Three-engine	• Continued introduction of wide-body aircraft and 727-200. • Introduction of new aircraft in the mid-1980s with seating capacity between 727-200 and wide-body aircraft. • Appearance of stretch versions of present wide-body aircraft in the mid-1980s.
*Four-engine	• Continued retirement of nonfan and older fan-jet aircraft. • Continued introduction of present wide-body aircraft.
• Seating Capacity	• Continued decrease in size of the first class section and a concommitant increase in the coach section. • Completion of the one-seat increase in the number of seats abreast in wide-body jets by the end of the 1970s.
• Passenger Load-Factor	• A gradual increase in the load-factor from the present 57 percent to 59 percent by the mid-1980s, and then increasing to 60 percent by 1990.

Revenue Passenger Miles

Status: Revenue passenger miles increased 13.2 percent during FY 1978, with both domestic and international travel showing substantial growth. Domestic RPMs were up 13.0 percent while international revenue passenger miles increased 14.1 percent, when compared with FY 1977. These increases were caused by two principal factors. One was the above average growth in the general economy that helped to increase air carrier growth. The other, and possibly the most important factor, was the increased implementation of discount fares which lowered the cost of air travel for many members of the traveling public.

Forecast: Demand for air carrier service is expected to continue to experience a higher growth rate than the general economy over the forecast period. Domestic RPMs are forecast to grow to 314.6 billion in FY 1990 from 172.1 billion in FY 1978 (see Figure 10). Total RPMs are expected to increase more rapidly than enplanements (85 percent growth by 1990 versus 73 percent), reflecting an expected rise in average passenger trip length.

Revenue Passenger Enplanements

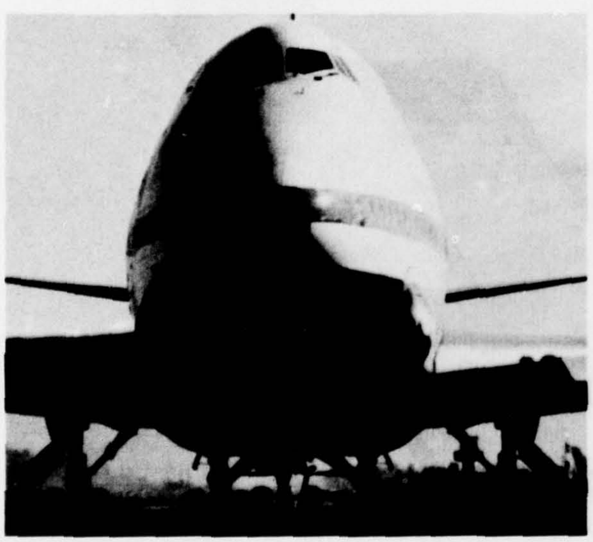
Status: Revenue passenger enplanements increased more than 12 percent, with domestic growing nearly 12 percent and international about 13 percent in FY 1978.

Forecast: Total revenue passenger enplanements of U.S. air carriers is forecast to reach 453.9 million in 1990, up 73 percent over the 1978 total of 262.4 million. Domestic revenue passenger enplanements are expected to increase by 71.4 percent and international enplanements by 92.5 percent.

Air Carrier Fleet

Status: As of January 1978, the air carrier fleet numbered 2,495 aircraft, approximately the same as the fleet size reported one year earlier.

Forecast: During the forecast period, the air carrier fleet will grow to 3,049 aircraft, 22 percent over the 1978 level.



Commuter Air Carriers

Methodology And Assumptions

An econometric model was used to generate 12-year national and terminal area forecasts for commuter passenger enplanements, operations, and fleet composition for the 48 contiguous states and Puerto Rico. In addition, those points likely to become candidates for commuter service in future years were identified.

Two sets of national forecasts are provided, one for all points receiving commuter service in 1978 and one for new points having potential for commuter operations. These new points include 110 airports or communities currently served by CAB certificated-route air carriers, but averaging less than 40 enplanements daily in 1976. Of these, 12 are served by Air Midwest and Air New England (newly certificated route air carriers who are likely to continue service) and 24 are currently served by commuter carriers. There remain 74 points that have potential for transfer of service to commuters. There are also approximately 50 communities not currently served, but with a population base and degree of isolation deemed sufficient to support new commuter service.

Enplanements at Puerto Rico are presented as a separate forecast because of the different characteristics of that service. A detailed discussion of commuter air carrier forecasts is found in the FAA publication: *Forecast of Commuter Airlines Activity* (FAA-AVP-77-28, July 1977).

Status And Forecast

Passenger Enplanements

Status: The number of airports receiving commuter service declined to 764 in 1977, from a high of 781 in 1976. For the same period, the number of carriers reporting data to the Civil Aeronautics Board declined to 242 operators. However, passenger enplanements continued to climb steadily, reaching 8.2 million in the 48 contiguous states plus Puerto Rico, an increase of 10.8 percent over 1977 (see Figure 11).

Forecast: Total domestic and Puerto Rico commuter enplaned passengers are expected to total 16.5 million by 1990, up 101.2 percent from 1978. This is an annual growth rate of 6.0 percent. The forecast for continued high growth in this industry reflects the assumption that the enactment of regulatory reform legislation will provide additional impetus for enplanement gains.

Revenue Passenger Miles

Status: During 1978, commuter revenue passenger miles rose 12.6 percent over 1977 levels to a new high of 941 million miles.

Forecast: It is expected that commuter carriers will fly a total of 2.1 billion passenger miles in 1990. This is a 121 percent increase over the estimated 1978 level, and represents an average annual growth rate of 6.8 percent.

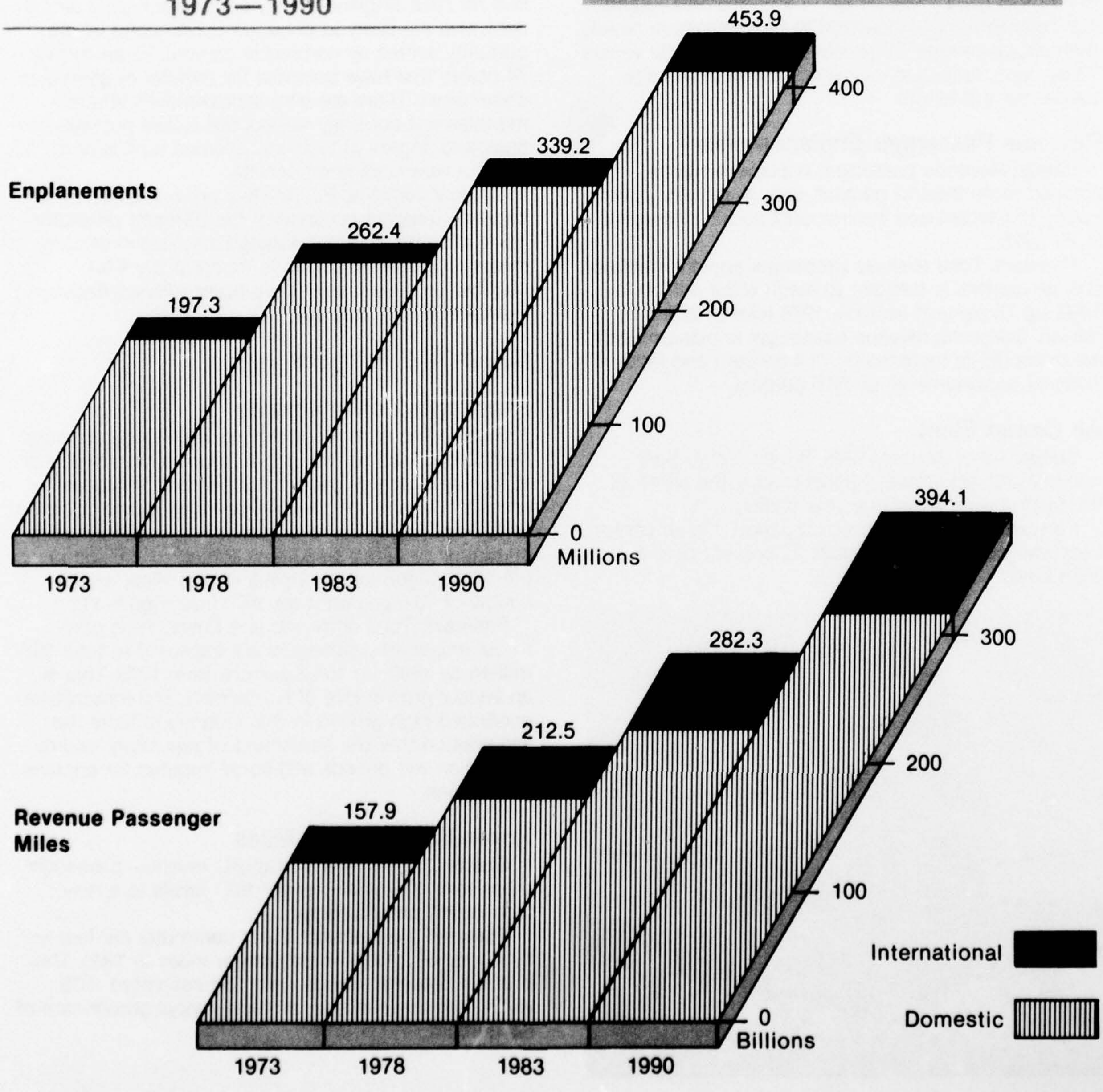
Aircraft Operations

Status: There were an estimated 3.1 million commuter operations at towered and nontowered airports during 1978. This is a 10.7 percent increase over 1977. These figures are based upon an assumed passenger boarding factor of 5.

Forecast: A total of 5.6 million operations are expected in 1990, which is 80.6 percent higher than the 1978 level. The passenger boarding factor is expected to increase to 6 by the end of the next decade.

Figure 10. Air Carrier Passenger Enplanements and Revenue Passenger Miles, Fiscal Years 1973—1990

	FY 1978 Status (Growth)	FY 1978—90 Forecast (Total Growth)
Enplanements	+ 12.0%	+ 72.9%
Revenue Passenger Miles	+ 13.2%	+ 85.5%



Air Cargo

Methodology And Assumptions

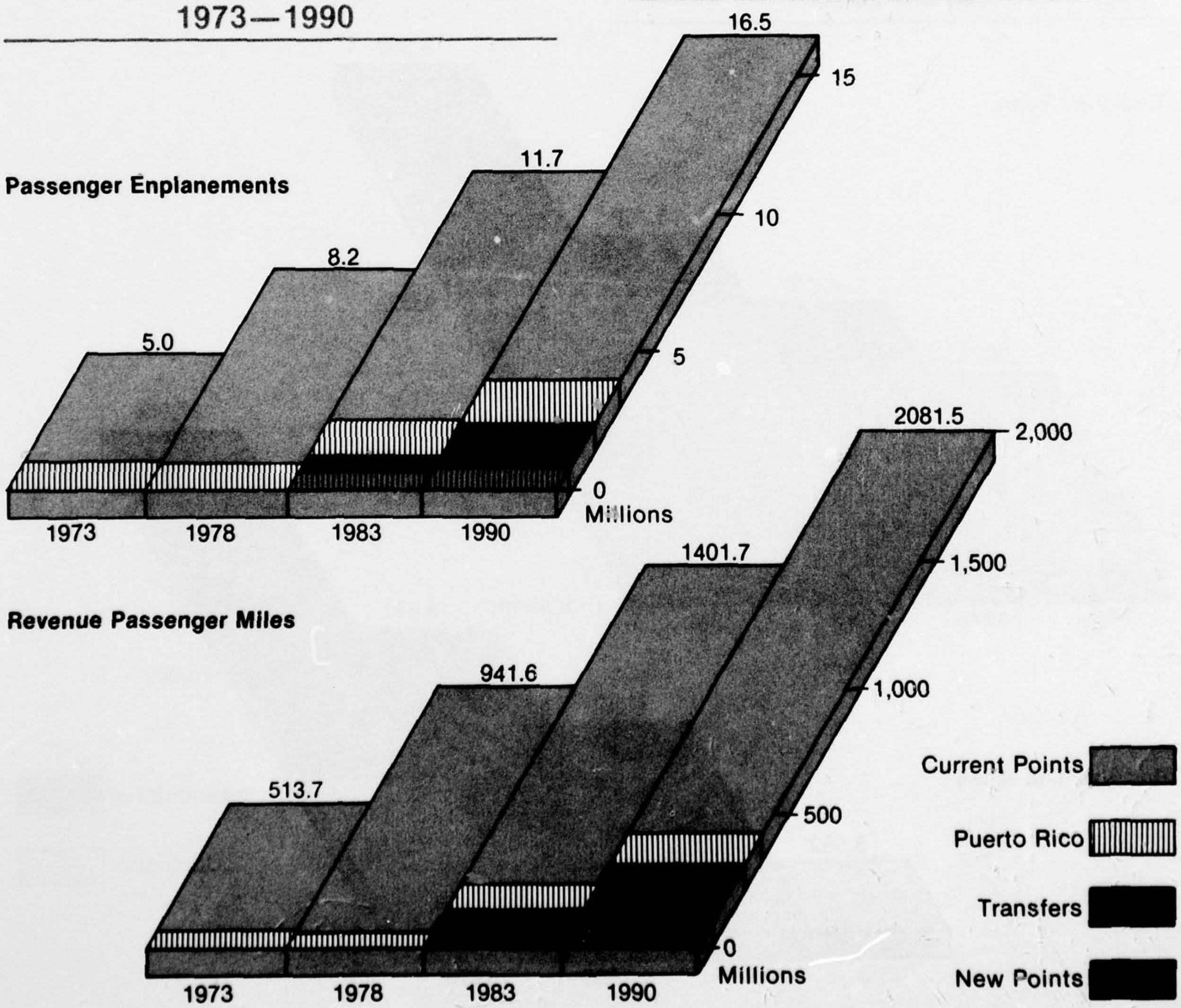
Forecasts are made for freight, express, and mail. Activity is assumed to be a function of the general economy of the United States and its world trading partners, the growth in time-sensitive cargo shipments, and differences in quality and prices for air and surface transportation modes. The relationship between these quantifiable variables and air cargo traffic is estimated by econometric forecasting models. One model forecasts revenue ton miles for domestic air cargo, while forecasts of revenue ton miles for imports from and exports to six world regions are accomplished by 12 other models.

The domestic model is based upon historical GNP data as reported by the Department of Commerce and upon revenue ton miles and average revenue yields (in constant 1972 dollars) for all scheduled and nonscheduled domestic air cargo services as reported by the CAB. The 1965-77 historical time period encompasses substantial variation in economic activity, technological innovation, and an increasing awareness of the benefits of air service.

The international models are based on a 13-year time series (1965-77) of U.S. imports and exports by air as reported by the Department of Commerce, and on average revenue yields (in constant 1972 dollars) for all scheduled and nonscheduled international air cargo services of U.S. flag carriers. Foreign flag

Figure 11. Commuter Carrier Passenger Enplanements and Revenue Passenger Miles, Calendar Years 1973—1990

	CY 1978 Status (Growth)	CY 1978—90 Forecast (Total Growth)
Enplanements	+10.8%	+101.2%
Revenue Passenger Miles	+12.8%	+121.1%



revenue data are not available, and it is assumed that average revenue yields would be equal to the yields of U.S. flag carriers. The national GNP is used as a variable for U.S. imports, and an aggregate gross product (in U.S. dollars) is used for each of six world regions for exports.

The air cargo econometric model is founded on the premise that no dramatic technological or sociopolitical change will occur in the forecast time frame. The models also assume that shippers and receivers choose their transport mode based upon economics and time sensitivities, and that these choices will remain essentially unchanged in the future.

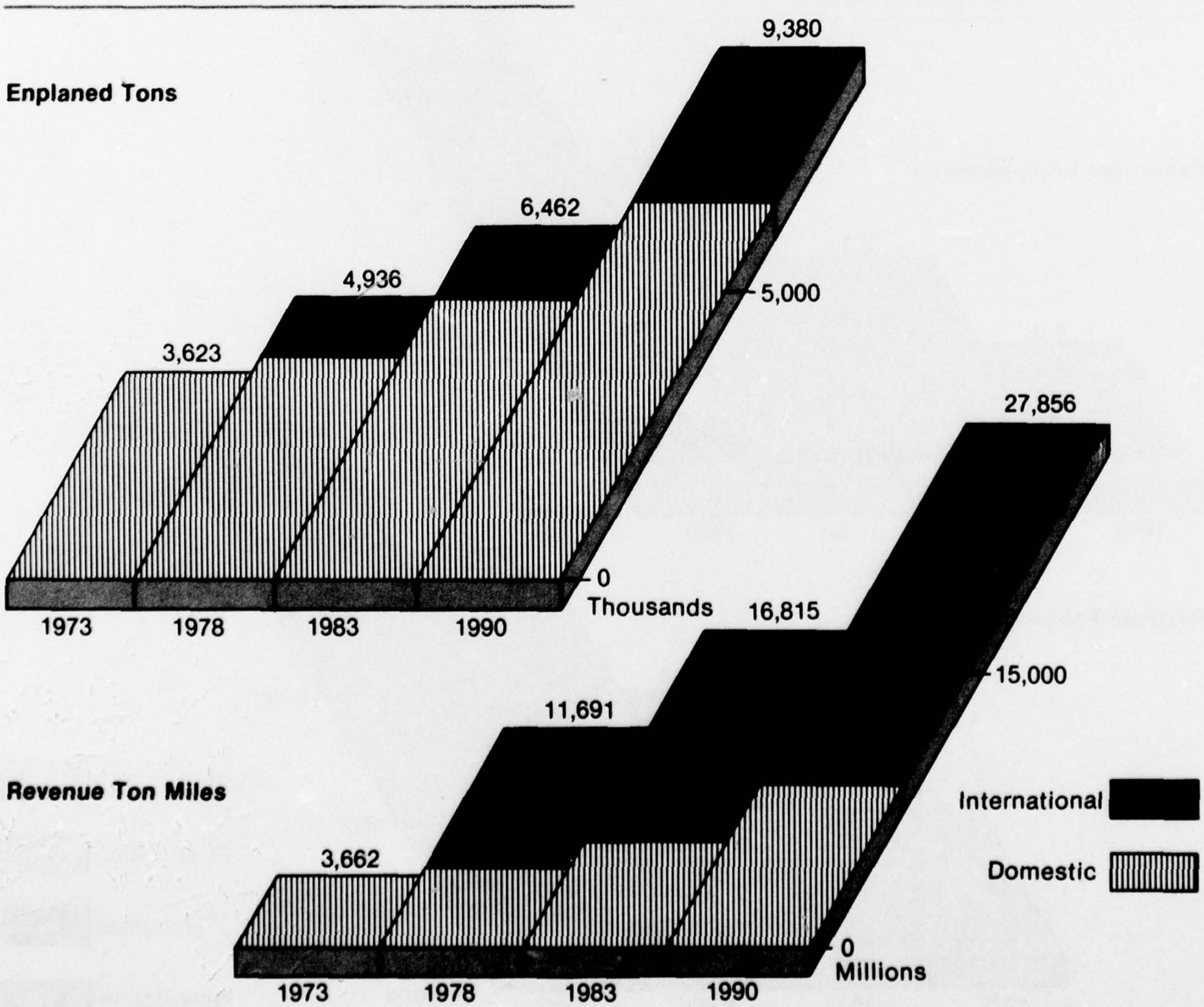
Status And Forecast

General

Air cargo will continue to be a selective service, used when benefits of quick movement, owing to an emergency, perishability, or high value/weight ratio, overshadow the net costs of inventory maintenance and movement. Since the Nation should continue to be a leading exporter of both agricultural goods and high technology items, air cargo can be expected to experience significant growth, despite increasing fuel costs.

Figure 12. Air Cargo Enplaned Revenue Tons and Revenue Ton Miles, Calendar Years 1973—1990

	FY 1978 Status (Growth)	FY 1978—90 Forecast (Total Growth)
Enplaned Tons	+7.2%	+90.0%
Revenue Ton Miles	+8.0%	+138.3%



The period of the 1980s should be marked by improvements in loading, recordkeeping, dispatching, and pickup and delivery services. Airlines are expected to improve their internal cargo-handling capabilities and their ability to move goods on and off trucks at airports. Should the Federal Government impose new cargo safety and security standards, costs would increase somewhat, but air cargo services would be more reliable and secure for shippers. The increasing value of land near airports may result in the development of new air cargo terminals located remote from existing airports. These facilities would have automated loading and unloading capabilities for trucks and rail cars, and would be located where good rail and road connections with surrounding areas are available. Thus, these new developments might be expected to stimulate the growth of air cargo.

Enplaned Revenue Tons

Status: Based on preliminary data, total air cargo enplaned revenue tons increased 7.2 percent to 4.94 million tons in CY 1978. Domestic enplaned tons rose 7.1 percent, while international enplaned tons rose 7.6 percent.

Forecast: Domestic air cargo enplaned tons are expected to increase 73 percent from 1978 to 1990, at an annual growth rate of 4.7 percent. International enplaned tons are forecast to grow even more rapidly at a 7.9 percent annual rate. In 1978, international enplaned tons are estimated to be 22 percent of total air cargo tonnage carried by U.S. carriers, while in 1990 international tonnage increases to represent 29 percent. Total enplaned tons are forecast to rise 90 percent from 1978 to 1990 (see Figure 12).

Revenue Ton Miles

Status: Total air cargo revenue ton miles were up 8.0 percent from 1977 to 11.7 billion in 1978. Domestically, the increase was 7.9 percent, and internationally the total was up 8.0 percent.

Forecast: Domestic air cargo revenue ton miles are expected to more than double during the forecast period, rising from 4.3 billion in 1978 to 8.8 billion by 1990. Average annual growth will be 6.2 percent. Freight and express are forecast to grow at a 7.0 percent annual rate, while mail will grow 1.5 percent a year. International air cargo revenue ton miles will increase more than 156 percent by 1990, at an average yearly growth rate of 8.2 percent.

Military Aviation

Methodology And Assumptions

All military aviation activity forecasts are based upon information provided by the Department of Defense and the United States Coast Guard. Detailed military planning extends through 1986, and remaining year forecasts are projected at the 1986 level by the FAA. Military operations are expected to hold nearly constant throughout the forecast period. Basic military activity elements (aircraft and flying hours) are translated into expected FAA air traffic workloads.

Status And Forecast

Active Aircraft

Status: The number of active military aircraft in the continental United States has decreased steadily from 1973 to 1977. In 1977, the 18,670 military aircraft were distributed as follows: 9,168 jets, 1,382 turboprops, 1,075 pistons, and 7,045 helicopters.

Forecast: Active military aircraft are expected to remain at the present level (near 19,000) for the entire forecast period. During this period, the military proportion of the total national fleet will fall to 6 percent from the current 10 percent. Compostion of the military fleet will show little change except for a further decline in piston-engined, fixed-wing aircraft to 2.1 percent of the total military fleet by 1990.

Aircraft Flying Hours

Status: Aircraft flying hours in the continental United States remained relatively stable in 1978, following a 9 percent decline in 1977.

Forecast: Total flying hours of military aircraft are expected to fluctuate narrowly between 5.5 and 5.7 million hours through 1990, growing slightly from the 5.5 million hours flown in 1978. Over this time period, the military proportion of total hours flown will fall to 7 percent from the current level of 11 percent.

FAA Operational Services

Background

The FAA provides the aviation community with three distinct operational services: air traffic control at selected airports, IFR enroute traffic control, and flight services, including pilot briefings, the filing of flight plans, and aircraft contacts. These services are provided to four major categories of users: the air carriers, the air taxis, general aviation, and the military. Because of different relationships and growth trends among these four users, there is no one workload measure (such as airport operations) or aviation activity series (such as air carrier revenue passenger miles) which typifies past trends or the future outlook for all FAA services. There have been, and there will continue to be, different socioeconomic and political forces which drive the growth trends in each major user category.

Methodology and Assumptions

The aviation forecasts for major user categories (air carrier, air taxi, general aviation, military aviation) are the foundation for forecasts of FAA operational services. First the underlying factors that influence growth patterns for each major user are determined and forecast. Based on these trends and past relationships, and through the use of econometric models, separate demand forecasts for FAA services are derived for each user category. Forecasts of total FAA operations and services are a summation of the individual forecasts for these major users.

Status and Forecast

General

Several factors may work to slow the growth in aircraft operations at towered airports over the coming years. Air carriers are expected to use higher-capacity aircraft and to increase load factors; environmental concerns, particularly with respect to noise, will continue; and general aviation may be restricted in its access to crowded hub airports. However, anticipated growth in air carrier operations, as well as in commuter and air taxi services that connect to air carrier flights, will, on balance, increase the overall number of operations.

In the 1980s, the need for increased capacity will be satisfied largely through improvements in existing air carrier airports, by improving reliever airports to serve as alternative landing facilities for general aviation traffic, and by using existing airports (such as Midway in Chicago) that lost traffic in the 1970s. At some airports, it may be possible to add short runways specifically for the use of air taxis and commuters, thus separating this traffic from long-haul jet airplanes. In addition, developments now being initiated to reduce wake turbulence are expected to decrease air traffic separation requirements, thereby increasing capacity on existing runways.

By the early 1990s, demand for airport services should be such that new airports will be required at several of the more congested hubs. This demand, plus improved financing capacity of airlines and airport sponsors, and an assumed availability of high-speed ground links from urban centers should make new airports feasible again. Lead times for airport construction will increase owing to difficulties associated with land acquisition, delays caused by environmental impact analyses, and coordination with state and local communities. Indeed, the escalating cost of land may make it advantageous to consider converting military airports where these are available.

Avionics aboard air carrier aircraft will increase in both quality and functions performed as a result of continuing miniaturization and cost reductions. Navigational accuracy should improve, and airborne collision-avoidance systems may become standard in the 1990s. However, the reduced cost in avionics will contribute to a rapid increase in general aviation IFR flights, beginning in the early 1980s. As a result, air carriers and other users of the aviation system will compete for air traffic control services in air spaces that will become increasingly congested.

Throughout the forecast period, the FAA plans to increase automation as a way of coping with the increasing demand for aviation services. However, despite large expenditures in research and development and major investments in implementation of research results, the growth in traffic volume will require increased manpower and facilities which, in turn, will increase overall ATC costs.

Improved air traffic control technology will continue to be introduced during the 1980s to reduce congestion, increase efficiency, and improve safety. Higher automation systems will continue to be developed throughout the forecast period, and improvements that could form the basis for a fourth generation system should begin going into the field by 1990.

The Federal Government will continue its responsibility for coordinating all transportation modes during the next decade. The FAA will continue to coordinate its activites with the other modal Administrations of the Department of Transportation. With congressional support, the agency will increase its funding of safety programs and for research and development of the airport and airways system. These FAA activities would be supported by increases in revenue (e.g., from ticket taxes and fuel excises) resulting from the increases in aviation activity.

Total Aircraft Operations

Status: FY 1978 total aircraft operations (takeoffs and landings) at airports with FAA air traffic control towers will remain at the FY 1977 level of 66.7 million, according to preliminary FY 1978 data.

Forecast: Total aircraft operations at towered airports are forecast to increase at an average annual rate of 3.5 percent, or by a total of 50.2 percent by 1990. Long-term activity forecasts are quite similar to those published last year, with slightly higher forecasts of itinerant operations being offset by lower growth in general aviation local operations. The forecasts for air carriers and military aviation are essentially the same as last year, while the forecast for air taxi operations is higher as a result of an-

ticipated regulatory changes that will encourage the use of air commuters for short haul travel (see Figure 13).

Instrument Operations

Status: A 3.8 percent increase in instrument operations was recorded between FY 1977 and 1978. This growth reflects the increased use of avionics by the general aviation fleet, as well as strong growth in air taxi and air carrier instrument operations. Military operations declined slightly from the 1977 level.

Forecast: Instrument operations at FAA towered airports are forecast to rise an average of 3.9 percent, or a total of 59 percent by 1990. These forecasts are slightly higher than last year's forecast. Strong growth in air taxi instrument operations (127.6 percent by 1990), attributable to increased commuter traffic and higher utilization of avionics, is expected to complement a significant increase (82 percent) in general aviation instrument operations (see Figure 14).

IFR Aircraft Handled

Status: In FY 1978, it is estimated that FAA Air Route Traffic Control Centers (ARTCCs) handled 28.1 million IFR aircraft, an 8.1 percent increase over the 26.0 million recorded in FY 1977. Air carrier IFR aircraft handled increased 4.6 percent, while the number handled for general aviation rose 18.8 percent over the same period. Air carrier traffic accounts for about 48 percent of the current IFR volume, followed by general aviation (29 percent), the military (16 percent), and air taxis (7 percent).

Forecast The forecast for workloads at ARTCCs through 1990 is higher than last year, primarily because the number of IFR-rated general aviation pilots is expected to increase. General aviation IFR-aircraft handled are expected to grow at a 6.8 percent annual rate from 1978 through 1990. Complementing this will be an expected 9.8 percent annual growth in air taxi IFR aircraft that are handled. Air carrier IFR operations should grow at a 2.1 percent annual rate. Zero growth is projected for military IFR activity (see Figure 15).

Figure 13. Total Aircraft Operations at Airports with FAA Traffic Control Service, Fiscal Years 1973—1990

	FY 1978 Status (Growth)	FY 1978—90 Forecast (Total Growth)
Itinerant Operations	+1.2%	+53.1%
Local Operations	−2.1%	+45.0%
Total Operations	0.0%	+50.2%

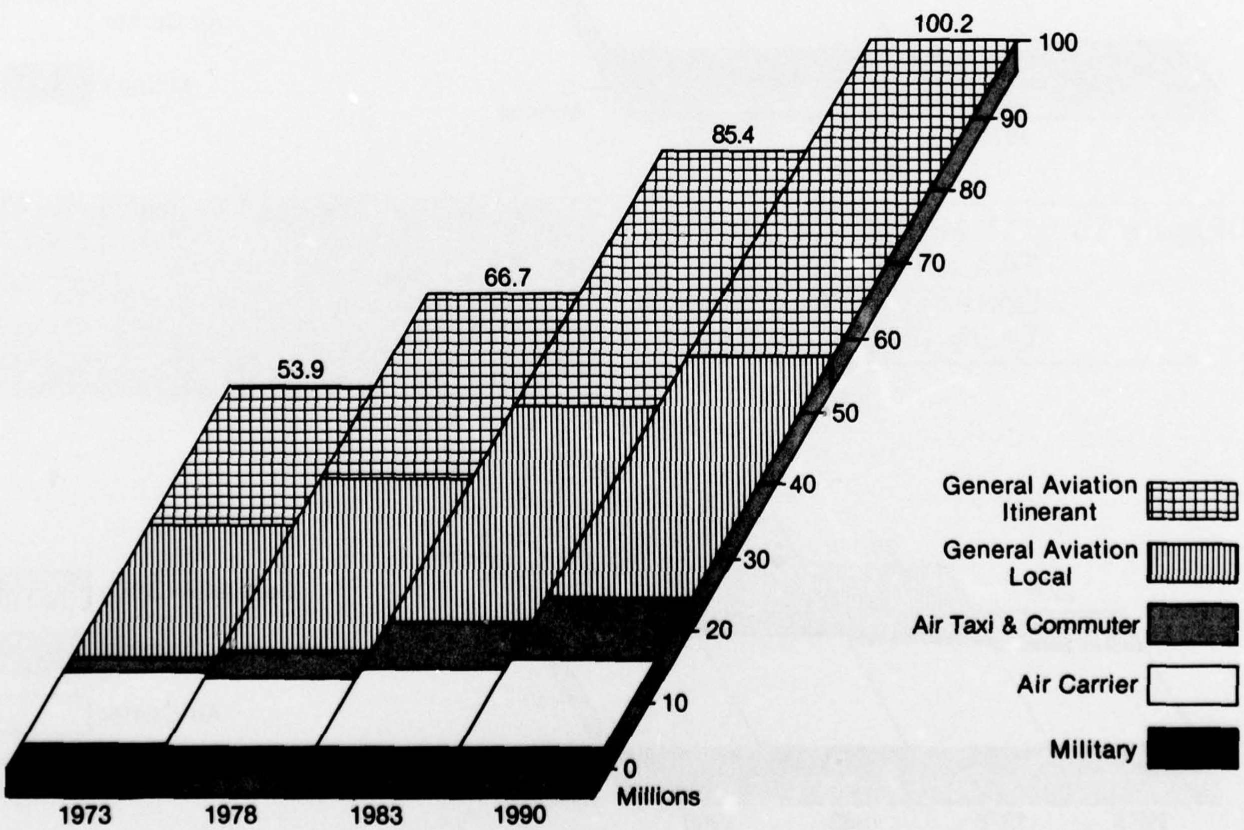


Figure 14. Instrument Operations At Airports With FAA Traffic Control Service, Fiscal Years 1973—1990

	FY 1978 Status (Growth)	FY 1978—90 Forecast (Total Growth)
Air Carrier	+ 5.0%	+ 26.7%
Air Taxi	+11.5%	+127.6%
General Aviation	+ 3.3%	+ 81.5%
Military	0.0%	0.0%
Total	+ 3.8%	+ 59.0%

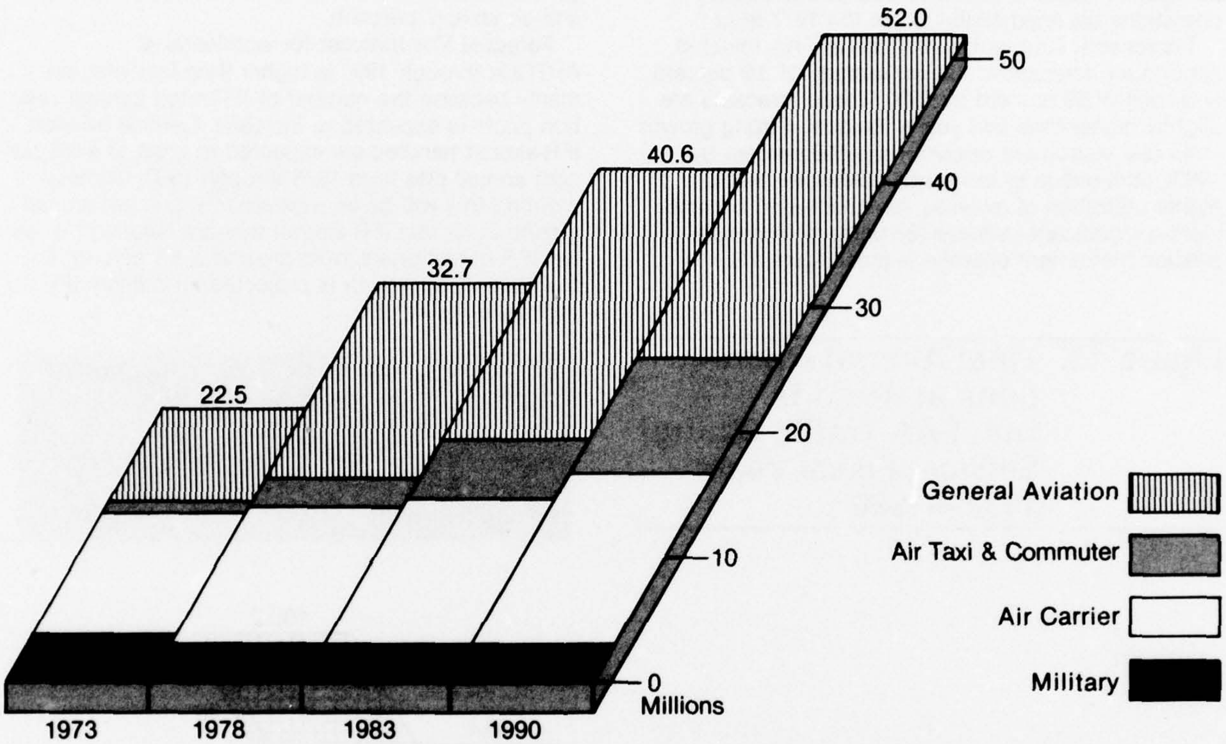
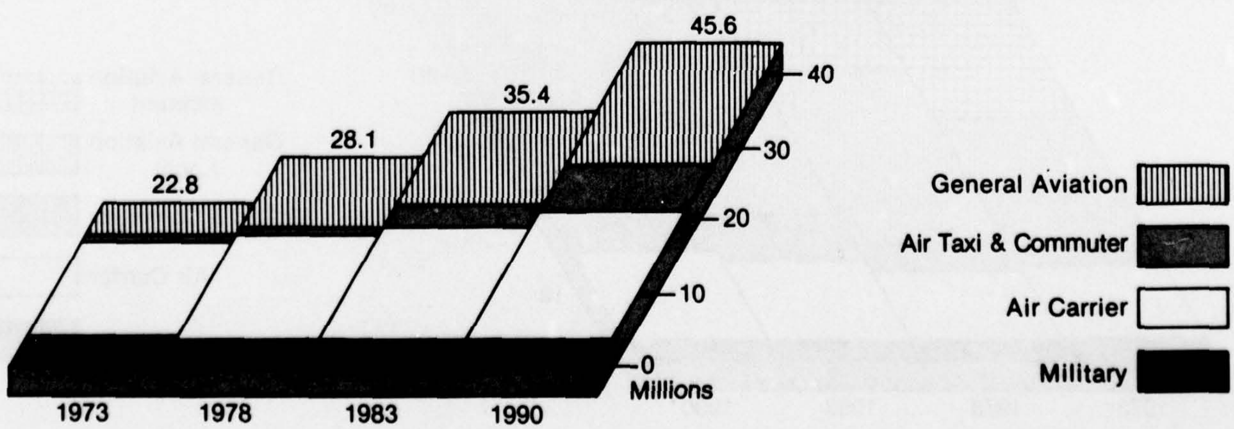


Figure 15. IFR Aircraft Handled by FAA Air Route Traffic Control Centers, Fiscal Years 1973—1990

	FY 1978 Status (Growth)	FY 1978—90 Forecast (Total Growth)
General Aviation	+18.6%	+119.5%
Air Taxi	+18.8%	+205.3%
Air Carrier	+ 4.8%	+ 27.9%
Military	0.0%	0.0%
Total	+ 8.1%	+ 82.3%



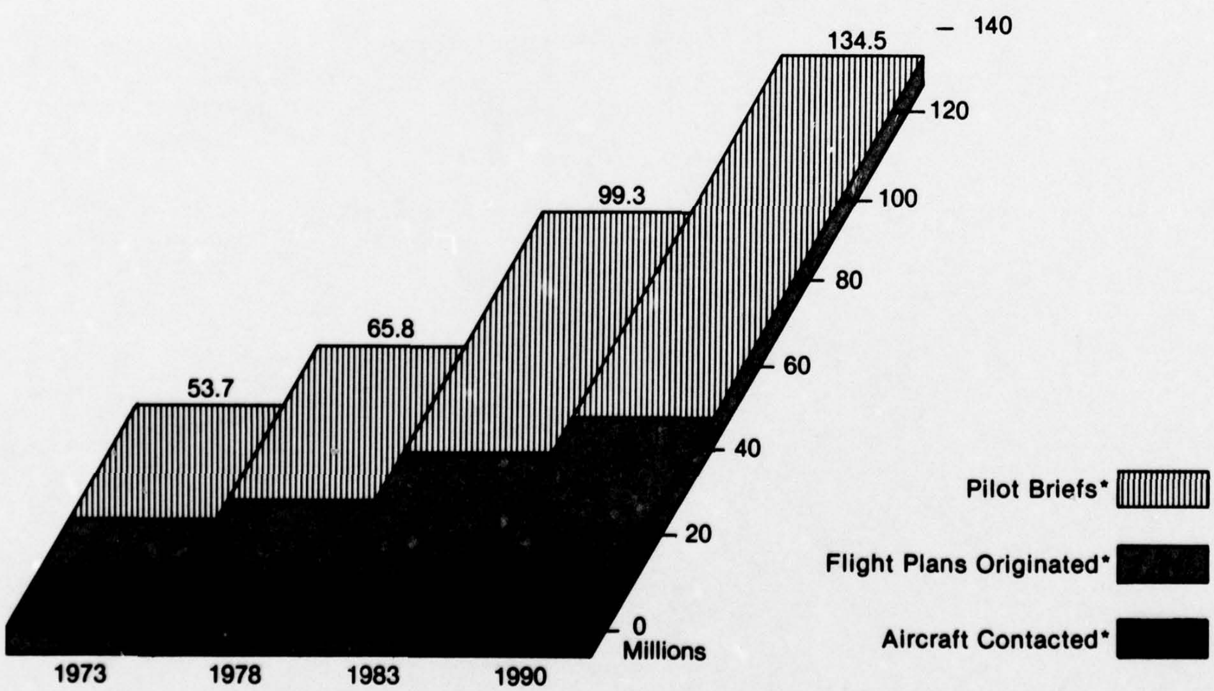
Flight Services

Status: FAA flight services include pilot briefings, the filing of flight plans and the contacting of aircraft. Historically, general aviation has generated the primary demand for flight services, and this trend is expected to continue. Between 1977 and 1978, total flight services provided by flight service stations and combined station/towers rose by 7.3 percent from 61.3 million to 65.8 million. In 1978, pilot briefs rose 7.7 percent, aircraft contacted 3.9 percent, and flight plans 8 percent.

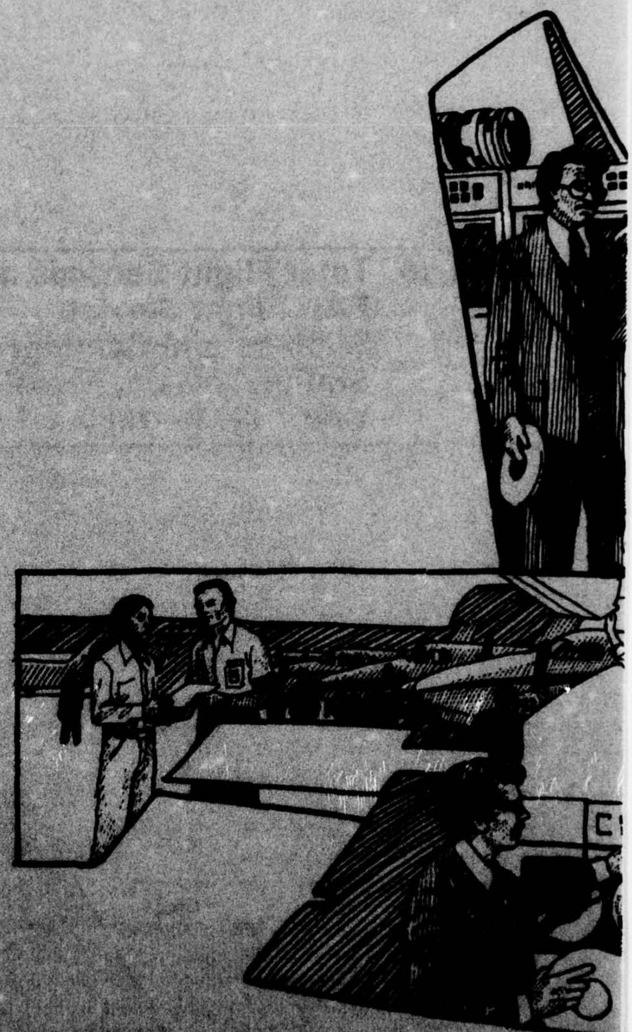
Forecast: By FY 1981, flight services are forecast to increase 31.3 percent over the 1978 level, reflecting continuation of the general economic recovery and an increase in IFR flying by general aviation. A slower growth rate in overall general aviation activity after FY 1983 will temper this growth somewhat. Yet, total flight services in FY 1990 are forecast to be more than double the current level. Over the forecast period, pilot briefs are expected to increase 132.4 percent and flight plans by 105.3 percent. In contrast, the number of aircraft contacted are expected to remain relatively unchanged throughout the forecast period (see Figure 16).

Figure 16. Total Flight Services at FAA Flight Service Stations and Combined Station/Towers, Fiscal Years 1973—1990

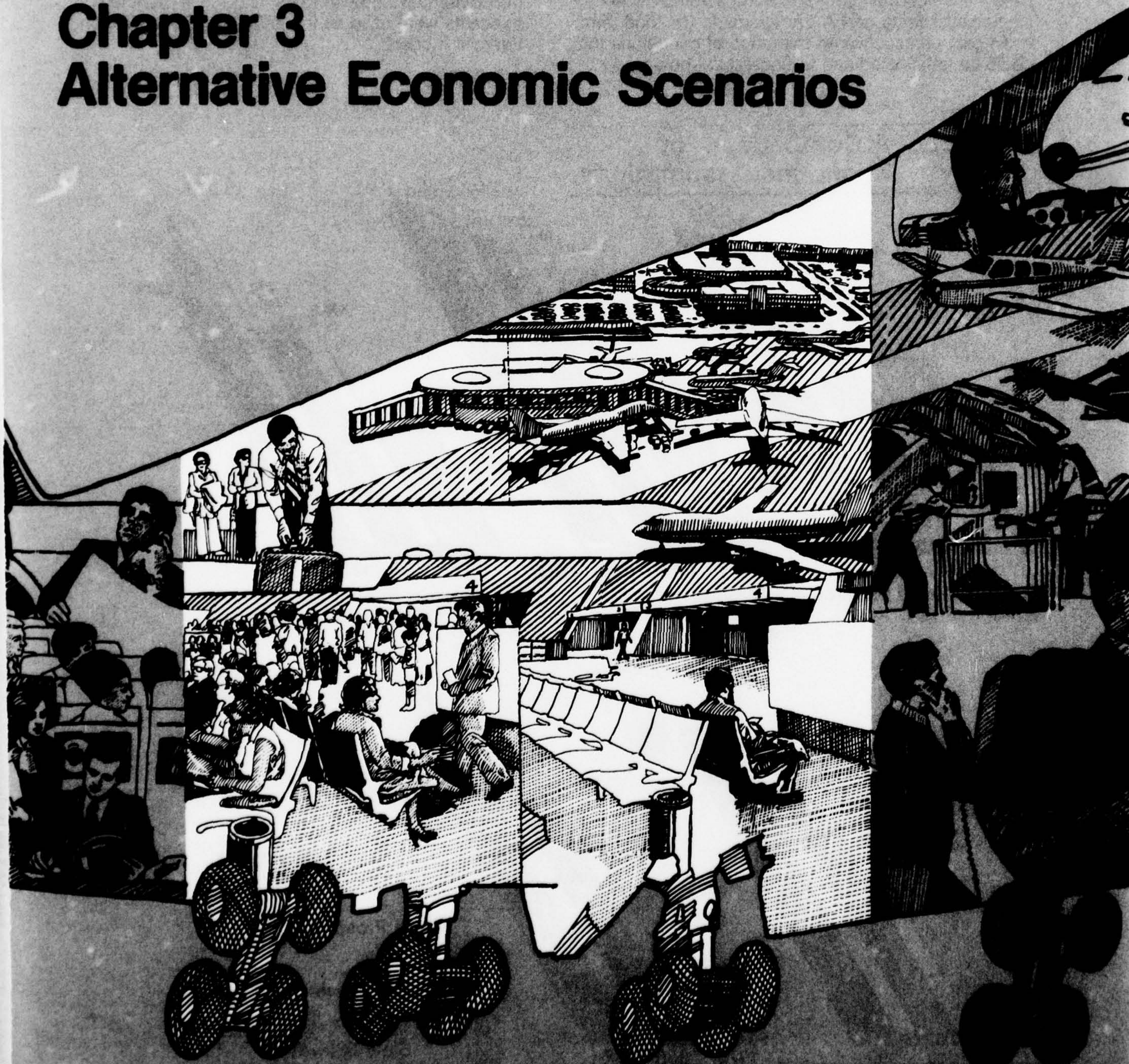
	FY 1978 Status [illegible]	FY 1978—90 Forecast [illegible]
Pilot Briefs	+7.7%	+132.4%
Flight Plans Originated	+8.0%	+105.3%
Aircraft Contacted	+3.9%	+ [illegible]%
Total	+7.3%	+104.4%



*Total Flight Services is a weighted workload measurement derived by multiplying pilot briefs and flight plans originated by two and adding the number of aircraft contacted. This figure depicts the components in their weighted form.



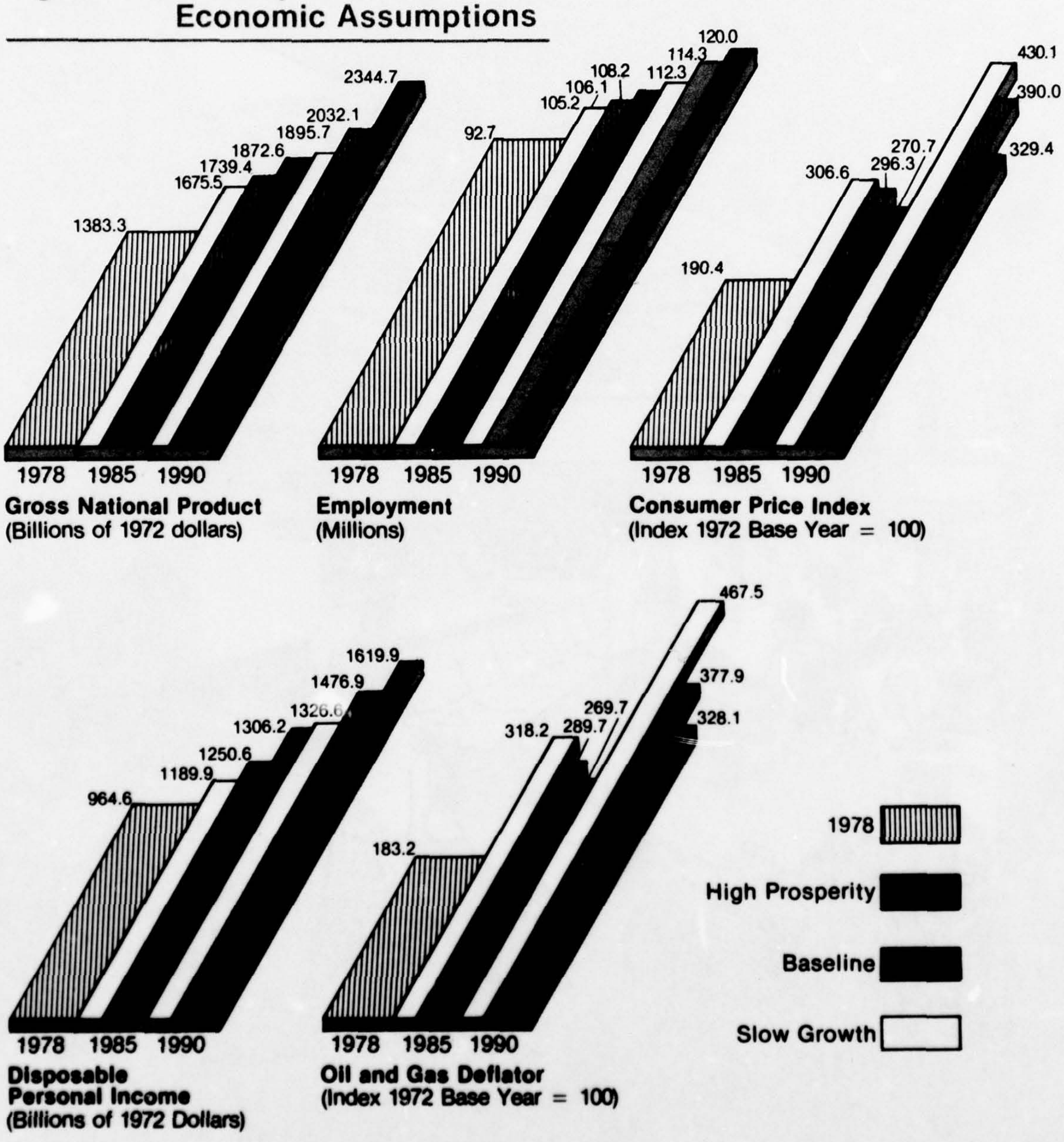
Chapter 3
Alternative Economic Scenarios



The baseline forecasts in Chapter 2 were developed from economic assumptions derived from the Wharton Long-Term Industry and Economic Forecasting Model. As is the case with all such models, predictive accuracy declines progressively as forecasts move further into the future. The baseline scenario is one possible outcome that could take place over the next 12 years; however, it is not the only one. Planning must anticipate variations from the baseline, since their cumulative impact could have significant effects on FAA programs in the long term.

To gain perspective on the range of conditions that could be anticipated and to understand how these alternative conditions could impact future aviation activity, two additional forecasts have been developed this year based on different assumptions about the future. The two alternative scenarios are labeled "High Prosperity" and "Slow Growth". Compared to the baseline forecast, they reflect respectively higher and lower levels of economic activity during the 1980s. To generate data for these scenarios, the Wharton economic forecasts were modified to produce alternative growth rates, and these modified forecasts were used as inputs to the FAA's aviation forecast models.

Figure 17. A Comparison of Economic Assumptions



The Wharton forecast values were assumed to apply through 1980, reflecting continuity of current economic policy. However, starting in 1981, the economy was assumed to experience either faster or slower growth relative to that of the baseline. The economic conditions for the two scenarios were chosen from historical U.S. experience. The "High Prosperity" scenario assumes the growth rates and related economic conditions experienced in the 1961-66 period. This period included a recovery phase from the 1960-61 recession followed by prosperous conditions. The "Slow Growth" scenario corresponds to conditions during the 1971-73 period. See Figure 17 for a comparison of the alternative economic assumptions.

The high prosperity and slow growth alternative scenarios are developed in parallel in the following discussion to ease comparison with each other and with the baseline (see Table 3). Variations in socioeconomic assumptions are discussed first, followed by the anticipated impact of such variations on selected segments of the aviation industry (see Figures 18 and 19). Finally, some implications of these alternative growth scenarios for the National Aviation System (NAS) are explored. A comparison of the 1990 values for each scenario and the baseline is presented in Table 3.

Table 3
Alternative Forecasts for FY 1990

	Slow Growth Scenario	Baseline	High Prosperity Scenario
Scheduled Domestic Passenger Traffic			
Revenue Passenger Miles (Billions)	266.4	314.6	350.8
Revenue Passenger Enplanements (Millions)	355.2	415.6	459.2
Fleet Size			
Air Carrier	2,890	3,049	3,210
General Aviation (Thousands)	289.4	310.8	329.5
Hours Flown (Millions)			
Air Carrier	7.2	8.0	9.0
General Aviation	60.7	67.4	72.7
Tower Operations (Millions)			
Total	86.5	100.2	117.8
Itinerant	58.2	65.7	70.8
Air Carrier	12.2	12.9	13.6
Air Taxi & Commuter	7.3	8.4	9.1
General Aviation	37.5	43.2	46.9
Military	1.2	1.2	1.2
Local	28.3	34.5	47.0
General Aviation	27.0	33.2	45.7
Military	1.3	1.3	1.3
Instrument Operations (Millions)			
Total	43.2	52.0	65.0
Air Carrier	12.5	13.3	14.0
Air Taxi & Commuter	5.4	6.6	8.2
General Aviation	21.7	28.5	39.2
Military	3.6	3.6	3.6
IFR Aircraft Handled (Millions)			
Total Handled	41.0	45.6	49.7
Air Carrier Handled	16.6	17.4	18.2
Air Taxi Handled	4.9	5.8	6.6
General Aviation Handled	15.3	18.0	20.5
Military Handled	4.4	4.4	4.4
Total Departures	16.8	18.6	20.3
Total Overs	7.4	8.4	9.1
Flight Services (Millions)			
Total	115.1	134.5	161.9
Pilot Briefs	35.9	42.3	52.5
Flight Plans Originated	16.9	19.3	22.0
Aircraft Contacted	9.5	11.3	12.9

Figure 18. A Comparison of Aviation Forecasts

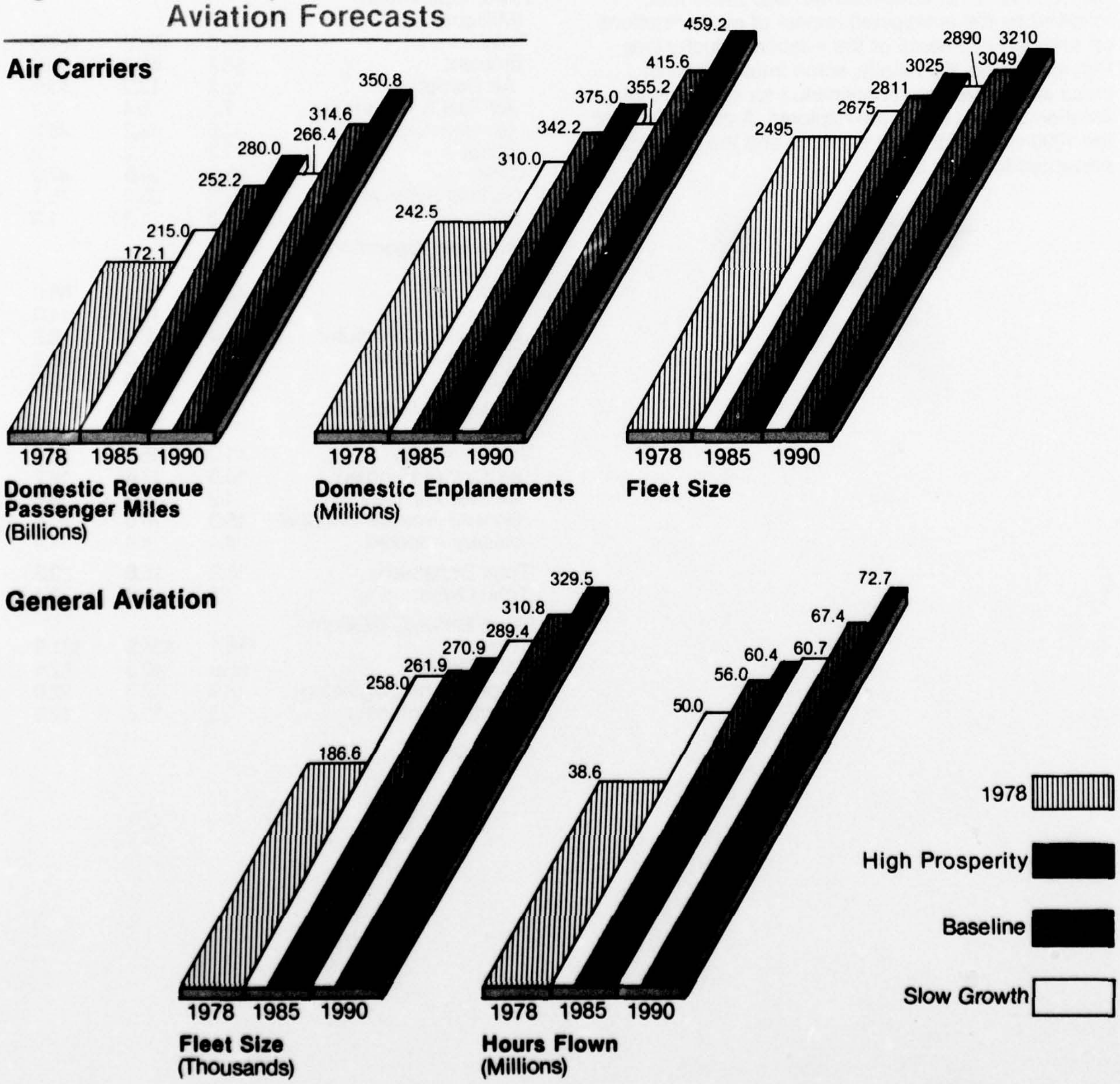
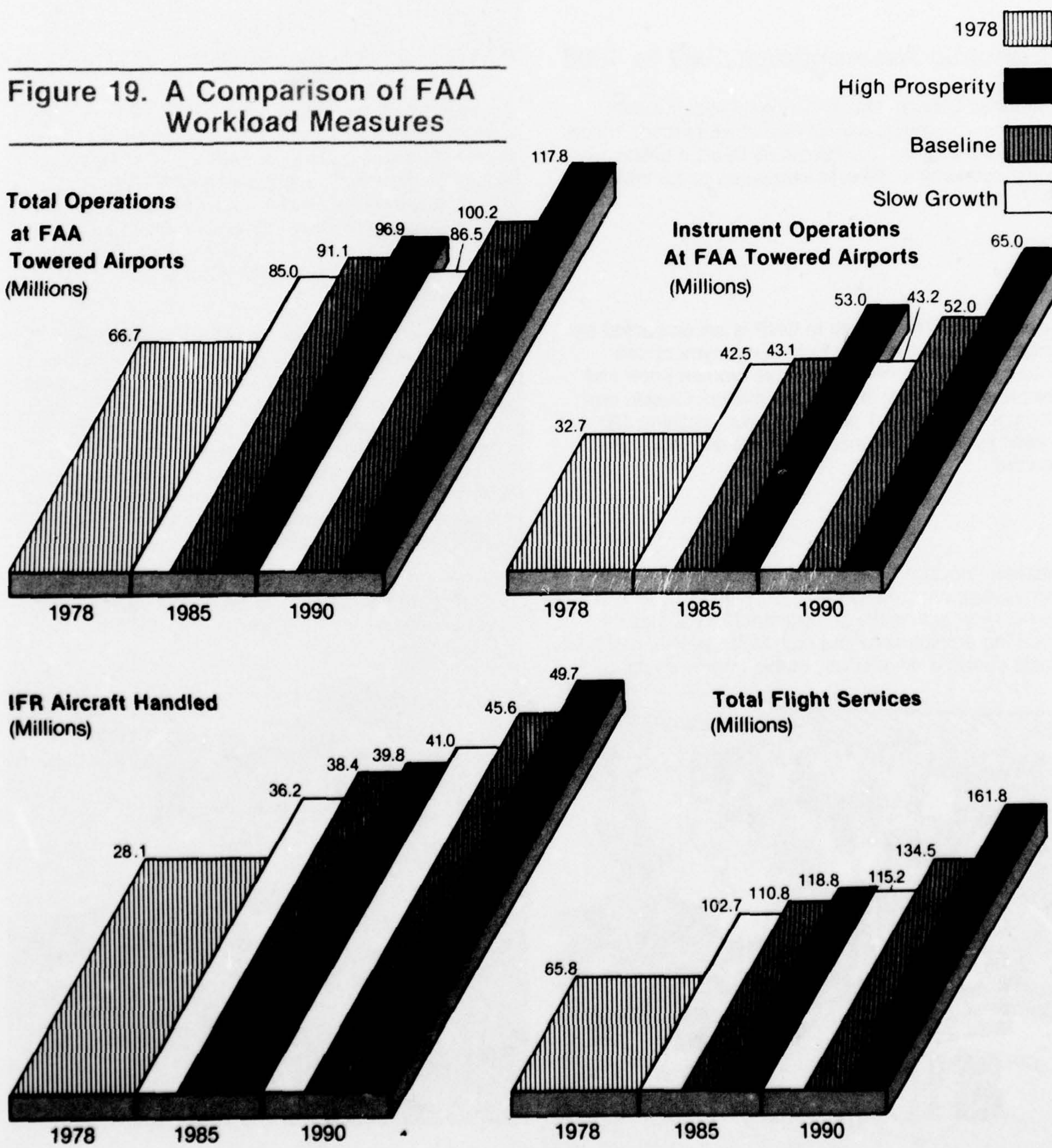


Figure 19. A Comparison of FAA Workload Measures



High Prosperity Scenario

General Conditions

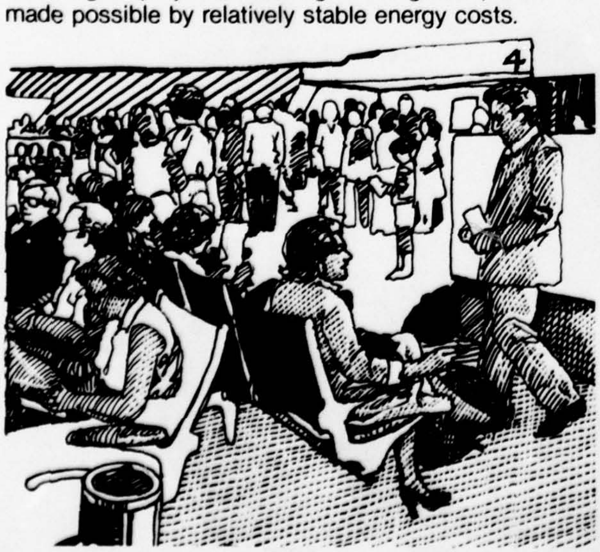
The investment in energy research and development (R&D) during the 1970s begins to pay off in the 1980s. A series of energy technology breakthroughs, coupled with energy conservation measures, assure an ample supply of fuel. The United States becomes less dependent on imported oil; the world price of petroleum drops; and the U.S. balance of payments comes into equilibrium. The resulting prosperity is reflected in rapid growth for both commercial and general aviation.

Economic Assumptions: 1980 to 1990

Economic Growth Gross National Product (GNP) grows at an average annual rate of 4.6 percent in constant 1972 dollars. This translates to a 2.4 trillion dollar economy in 1990, as compared to 1.3 trillion in 1977.

Employment The growth in GNP is accompanied by strong gains in the labor force. Employment continues to grow as more and more women enter and people over 65 stay in the labor market. Civilian employment rises by 2.1 percent a year, reaching 120 million by 1990. The unemployment rate drops to 4 percent.

Inflation Inflation rates are kept under control, with the average annual rise being 4.1 percent. This is a particularly remarkable achievement in the face of booming employment and high GNP growth, and it is made possible by relatively stable energy costs.



Slow Growth Scenario

General Condition

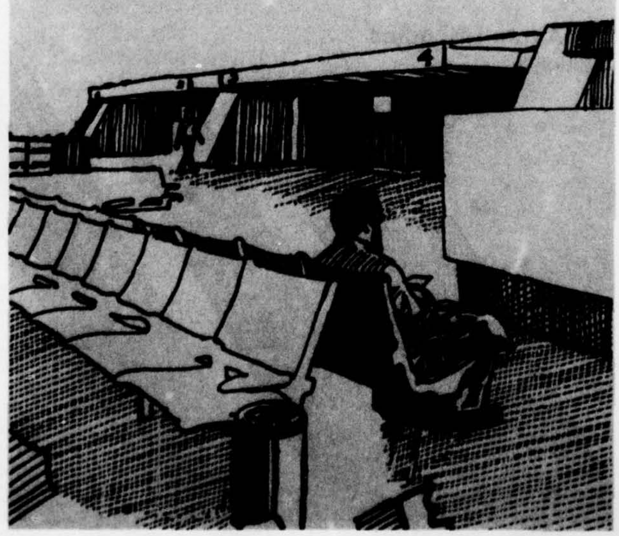
With few new energy discoveries, strong national concern for the environment precluding the use of "dirty" fuels, and failure of new technologies to come on line, the world supply of energy does not keep pace with demand. The world price of oil and natural gas rises steadily. The United States becomes increasingly dependent on foreign energy and is unable to sustain its technological lead in the world. As a result, economic growth slows to near-recession levels.

Economic Assumptions: 1980 to 1990

Economic Growth The economic recovery that began in 1975 runs its course by 1980, and a period of slow economic growth sets in. A shortage of energy, persistent "stagflation", and growing protectionism throughout the world make it difficult for the United States to compete in world markets. An average annual economic growth of 2.4 percent per year during the 1980s results in a 1.8 trillion dollar GNP (constant 1972 dollars) in 1990.

Employment Unemployment remains at relatively high levels. The number of young entrants to the labor market declines in the 1980s owing to the lower birth rates during the 1960s. However, increasing numbers of women and people over 65 join those looking for work. The economy is able to absorb only a 2.3 percent increase in the labor force each year between 1980 and 1985, and only 1.3 percent per year between 1985 and 1990. Total employment reaches 112 million in 1990, and unemployment is 7.4 percent.

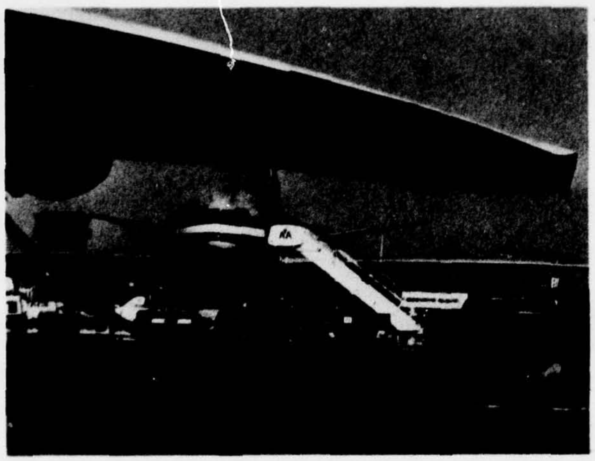
Inflation Despite various Government efforts to control inflation, a steady 7 percent annual inflation rate is experienced during the 1980s.



Consumer Spending The growth in GNP and employment lead to rapidly rising disposable personal income. The growth in consumption of services is 4.3 percent between 1980 and 1985, and 4.4 percent between 1985 and 1990.

Fuel The energy advances of the 1980s lead to stabilization of fuel costs. Fuel for aviation is plentiful, but fuel price rises in proportion to the general inflation rate.

Regulatory Reform Regulatory reform leads to results even better than those forecast by its advocates. Competition among carriers increases, and passenger volumes grow to absorb the new capacity that is offered. The net effects are an increase in air carrier operations, improved quality of service, more rapid introduction of new aircraft and retirement of existing aircraft, and a slower rise in the price of air fares.



Consumer Spending The slow growth in GNP and rather high inflation combine to retard real growth in consumer spending to 2.3 percent a year. This low growth in spending affects commercial aviation severely.

Fuel Although aviation fuel is available in sufficient quantity to meet demand, fuel price continues its upward spiral. Jet fuel prices increase from 35 cents/gallon, typical in 1978, to 90 cents/gallon in 1990.

Regulatory Reform Regulatory reform, coming during a time of slow economic growth, results in a restructuring of the aviation industry. Because of poor economic conditions, airlines are not able to stimulate growth in passengers by lowering fares. More routes are abandoned to commuters, and fares are raised for commuter and air carrier passengers. After several airline mergers in the mid-1980s, the air carrier industry concentrates on serving the business passenger.

Forecasts of Aviation Activity

Air Carrier

Domestic Demand for services increases for all modes of transportation as a result of expansive growth in business activity, leisure time, and income. The air carrier system becomes the primary means for long-distance travel for both business and pleasure, while medium-distance travel tends to be divided among the aviation system, high-speed ground transportation, and the private automobile. Domestic revenue passenger miles more than double, increasing from 171 billion in 1978 to 351 billion in 1990. In general, air carrier service is subdivided into two main categories: higher-cost, regularly scheduled, high-frequency service for time-conscious business travelers and low-cost, high-load service for pleasure travelers.

Aircraft fuel efficiency improves significantly, and aircraft noise levels are reduced as a result of accelerated fleet turnover. Several new aircraft are developed, as well as new configurations of large jumbo jets seating nearly 600 passengers. The average seats per aircraft increases to 193 by 1990.

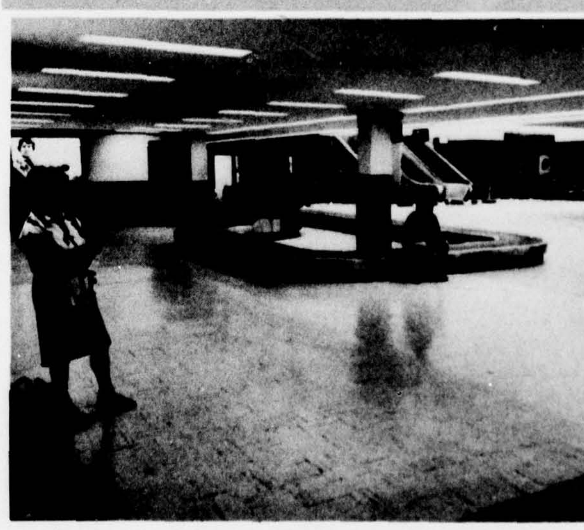
International An expansion in international trade and disposable personal income results in a boom for international aviation. Tourism is spurred by the increasing availability of leisure time and income. A corresponding growth in affluence abroad and advantageous exchange rates spur U.S. export sales and business travel. This combined with variable class air fares, entice large numbers of foreign visitors who perceive the United States as one of the more desirable vacation destinations. The United States is able to negotiate favorable bilateral agreements on landing rights, and U.S. carrier international revenue passenger miles reach 100 billion in 1990. Average annual growth remains high at 7.3 percent.

Forecasts of Aviation Activity

Air Carrier

Domestic Relatively static personal income combines with high costs to depress the demand for air transportation. Air carrier operations increase only 14 percent between 1980 and 1990. Total air carrier operations (including international) at towered airports increase by less than 700,000 between 1980 and 1990. Revenue passenger miles experience a greater growth, increasing about 36.6 percent, and the number of enplaned passengers grows by 28.7 percent. This growth is accommodated through the use of slightly larger aircraft and relatively constant load factors. Fares increase slowly but steadily, and service quality is reduced.

International International trade grows slowly over the forecast period, resulting in slow growth for international air transportation. There is slow but steady growth in business travel; however, tourism remains relatively stagnant. International passenger enplanements by U.S. flag carriers grow 14.3 percent between 1980 and 1990, and revenue passenger miles increase to 66 billion, as compared to 84.3 billion forecast for the baseline case.



General Aviation

The expansive growth of income, leisure time, and business activity results in a boom for general aviation. A pilot's license and access to an airplane become a commonly pursued status symbol. General aviation operations grow nearly 60 percent from 1980-1990. Total private and commercially licensed pilots increase to more than a million by 1990. Over half a million pilots receive instrument ratings.

The growth in general aviation is accompanied by rapid advances in technology. Small aircraft stability and control mechanisms are improved to the point where the skills required by pilots are not significantly greater than those required to drive an automobile. Advances in avionics make navigation and communications equipment much lighter, less expensive, and simpler to operate. As a result, even the smallest aircraft can be equipped to use automatically programmed flight plans.

General Aviation

Operating costs for general aviation increase faster than the inflation rate as a result of significant increases in fuel costs and additional maintenance requirements on an aging fleet. By 1985, it is evident that fewer individuals can afford to own their own aircraft. The number of student pilots begins to decrease in 1981 and continues to decline throughout the 1980s. By 1990, student pilots are down to 174,500 from 203,500 in 1978. Corporations attempt to balance the increasing costs of general aviation flying against the general economic uncertainties and the increasing cost of commercial flights. The results are mixed, as some corporations discontinue ownership and rental of business aircraft, while others increase their use of such aircraft. The number of pilots with commercial licenses increases from 220,100 in 1980 to 281,000 in 1990.

Low demand for new aircraft results in an aging fleet with few improvements. Pleasure aircraft sales shift increasingly to lower technology, more fuel-efficient aircraft. The 1980 general aviation airport system remains basically adequate through 1990. However, reductions in the cost of navigation aids and communications and electronics equipment result in general aviation aircraft being more fully equipped to use the ATC system. The volume of controlled general aviation flights handled by air route traffic control centers (ARTCCs) more than doubles the 1978 levels and reaches 15.3 million in 1990.

Air Cargo

Air cargo revenue ton miles (RTMs) increase at an 8.5 percent average annual rate owing to rapid growth in the domestic economy and foreign trade, particularly in high technology products and perishable foods. Most cargo growth is accommodated in the belly holds of passenger-carrying aircraft, but all-cargo activity experiences a sufficiently rapid growth to prompt planning for all-cargo airports. The carriers make significant improvements in their ability to move cargo by air and within their own cargo areas, but are limited by their inability to move cargo in and out of airports efficiently.

Air Cargo

With aircraft technology relatively stable and engine fuel improvements barely keeping up with increasing fuel costs, there are no new price advantages gained by the use of air cargo as opposed to other modes. Annual growth in air cargo RTMs increases slowly, reaching 5.7 million ton miles in 1990.

Implications of the High Prosperity Scenario

In the high prosperity scenario, activity levels would be reached two or three years earlier than forecast for the baseline. This accelerated growth would necessitate a speed up in implementation of the National Aviation System (NAS) technological capabilities. The FAA would be faced with the choice of either replicating existing facility types, resulting in accelerated manpower requirements, or the implementation of advanced technologies. Both courses have cost and risks; however, it is anticipated that capital would be available.

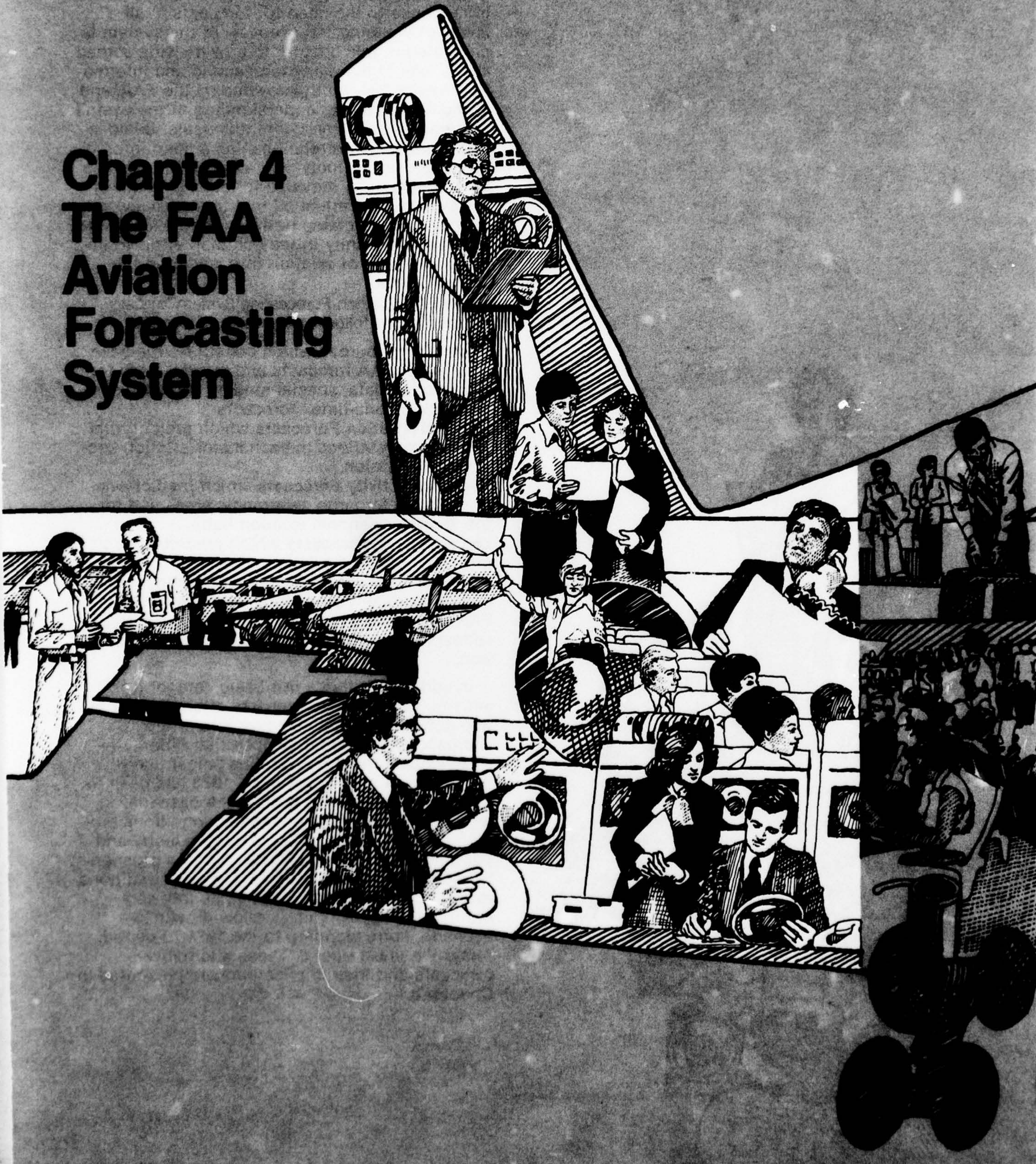
The growth in general aviation would impose the greatest new burden on the Air Traffic Control (ATC) system. By their sheer numbers and increasing electronic sophistication, general aviation aircraft would become the primary ATC workload in enroute as well as in terminal airspace.

The growth in international flights would necessitate the installation of advanced satellite-based ATC systems for both the Atlantic and the Pacific in the 1980s. These systems would monitor aircraft through the transoceanic flights, allowing reduction in airspace separations and an attendant increase in the capacity of over-ocean routes.

Implications of the Slow Growth Scenario

If the slow growth scenario occurs in the United States, the level of aviation activity, and hence the demands on the NAS, would be approximately two years behind those anticipated under the baseline scenario in 1990. That is, the slow growth activity levels in 1990 would be approximately equal to the 1988 activity levels in the baseline case. The NAS development and implementation schedule could be slowed, since capacity limitations would not be reached as quickly in specific locations or on specific route segments and because the on-board technology generally available in aircraft would be lower. With lower growth in demand for commercial aviation, as exemplified by lower revenue passenger miles and enplanements, capital for investment would be in short supply and purchases of new aircraft would be delayed. The pace of retrofit of engines for lower noise might be slowed. However, increasing fuel prices would encourage engine improvements that achieve lower fuel consumption. It can also be anticipated that new technology would be introduced into the NAS at a slower rate than in the baseline case.

Chapter 4
The FAA Aviation Forecasting System



The FAA Aviation Forecasting System has gradually evolved to the form shown in Figure 20 in response to the need for forecasts at all levels of planning. An overview of the system is presented in this chapter to provide wide spread awareness of the many forecasting and information services currently provided by the FAA, and to facilitate a better understanding of the overall system by current and potential users. Besides displaying the interrelationships among information sources and individual aviation forecasts, a short synopsis is provided for each element of the system. It is intended that this overview will facilitate future dialog between the FAA and the aviation community in the common effort to improve all levels of aviation forecasting in the United States.

The FAA Aviation Forecasting System logically divides into the following five basic categories:

Information Sources which constitute the base data for all FAA forecasts and may take the form of compiled data, special studies and analyses, or specific "one-time" forecasts.

National Aviation Forecasts which project total growth expectations in each major aviation sector for the Nation.

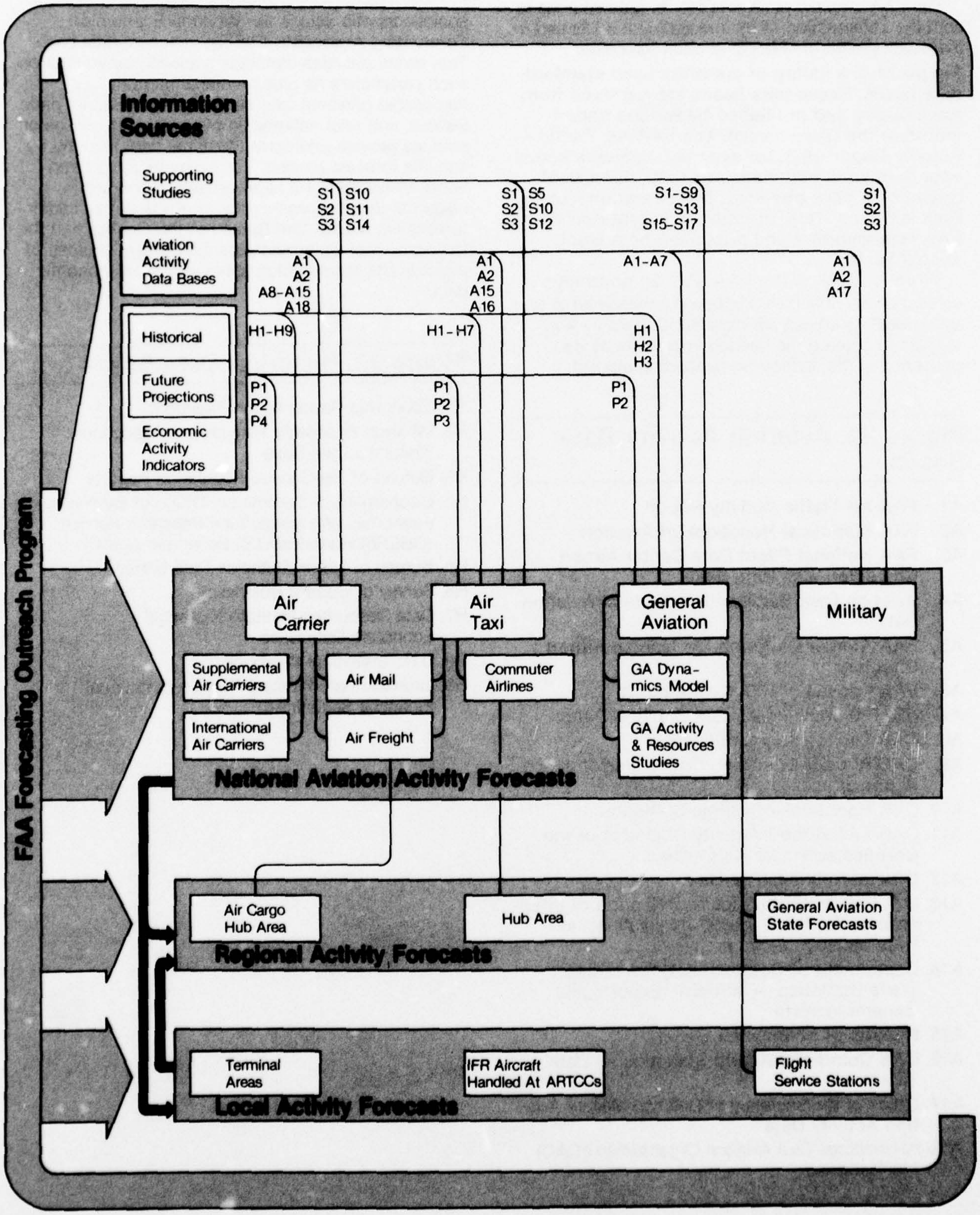
Regional Activity Forecasts which predict aviation growth for large geographic areas and for the 25 major national aviation hubs.

Local Activity Forecasts which predict aviation growth at specific aviation sites.

The FAA Forecasting Outreach Program which embodies recent procedural changes in the FAA's forecast-generating process to achieve widespread regional, state, and local participation.

In addition to these five basic categories of activity, the FAA also prepares alternative aviation activity forecasts for possible future socioeconomic circumstances that differ substantially from the baseline "most likely" projection. A major goal in FY 1978 has been to define plausible limits around the baseline, which is derived from economic conditions projected by the Wharton Long-Term Industry and Economic Forecasting Model. A "high prosperity" scenario, reflecting the economic conditions experienced during the 1961-65 period, constitutes the upper limit. A "slow growth" scenario, corresponding to the 1971-73 period, forms the lower bound. These alternative forecasts and their implications are presented in Chapter 3.

Figure 20. The FAA Aviation Forecasting System



Information Sources

Aviation Activity Data Bases

The FAA employs a wide variety of data sources in both the construction of its forecasting models and in the development of specific aviation forecasts.

Figure 21 is a listing of currently used standard data bases. These data bases are gathered from the industry and published by various departments of the Government. The FAA Air Traffic Activity Report (A1), for example, contains actual counts of workload measures (e.g., number of operations, pilot briefings, IFR operations) at FAA facilities. This information is reported to FAA Headquarters and published on a semiannual basis.

While supplying the FAA with an enormous volume of valuable data, important improvements to this overall data base are required. Current FAA initiatives to achieve the needed improvement are described in the section on supporting studies.

Figure 21. Aviation Activity Data Bases

A1. FAA Air Traffic Activity Report
A2. FAA Statistical Handbook of Aviation
A3. FAA National Flight Data Center Airport Characteristics Data Base
A4. Aviation Data Service, Inc., General Aviation Data
A5. FAA Airman's Information Manual Airport Directory
A6. FAA Census of U.S. Civil Aircraft
A7. USAF Worldwide Airfield Climatic Data
A8. CAB Service Segment Data
A9. CAB Aircraft Operating Cost & Performance Report
A10. CAB Handbook of Airline Statistics
A11. CAB/FAA Airport Activity Statistics of the Certificated Route Air Carriers
A12. Official Airline Guide Data
A13. U.S. Department of Justice, Reports of International Passenger Travel, Immigration and Naturalization Service
A14. Department of Commerce, U.S. Foreign Trade Statistics — Airborne Exports and General Imports
A15. Reports of Postmaster General
A16. CAB Commuter Airline Statistics — Data Tapes
A17. Office of the Secretary of Defense Military Aviation Activity Data
A18. International Civil Aviation Organization (ICAO) Publications

Economic Activity Indicators

Historical Data: Figure 22 lists the data sources used as historical bases of socioeconomic conditions for the construction of FAA aviation forecasting models. The primary source for national socioeconomic data is the Wharton Economic Forecasting Associates (WEFA) historical data base. This series provides historical socioeconomic data on such parameters as gross national product, disposable personal income, fuel and consumer price indices, and total national employment. Various other sources provide additional historical data required by specific forecast models. For example, the International Monetary Fund supplies selected world historical data required by the international air carrier forecasting model. The Bureau of the Census and the Department of Commerce are the primary sources of regional and local demographic and socioeconomic data.

Figure 22. Historical Data Bases

H1. Economic Report to the President
H2. Wharton Economic Forecasting Associates Historical Data Base
H3. Bureau of the Census Population Reports
H4. Department of Commerce, Office of Business, Economic, and Agricultural Research Service (OBERS) Historical U.S. Economic Activity
H5. Bureau of Labor Statistics Data Series
H6. Survey of Current Business
H7. Data Resources Institute Historical Economic Data Base
H8. U.N., Statistical Yearbook
H9. International Monetary Fund, International Financial Statistics

Future Predictions: Figure 23 lists the sources used by the FAA for projections of future socioeconomic conditions. These projections constitute the input socioeconomic assumptions to the various FAA forecasting models from which the baseline forecasts of aviation activity are generated.

Wharton Economic Forecasting Associates is the FAA's basic source for national socioeconomic projections and the Data Resources Institute is employed as a secondary confirmation source. Projections of economic activity at the regional and local levels are generated by the Department of Commerce. A major initiative is now underway at the FAA to supplement and verify these projections through direct contact with local officials. Such activities are described in detail in the section on the FAA Forecasting Outreach Program. Aggregate worldwide economic activity is provided by Wharton Associates, while forecasts for individual countries are obtained from SRI International.

Figure 23. Forecasting Data Bases

P1. Wharton Economic Forecasting Associates Economic Forecasts

P2. U. S. Department of Commerce, OBERS Projections of U.S. Economic Activity

P3. Data Resources Institute Economic Forecasts

P4. SRI International, International Economic Forecasts

Supporting Studies

Each year, the FAA conducts or obtains special studies (Figure 24) to develop data and insight not supplied by the standard sources (Figure 21). These studies may take the form of one-time forecasts in response to specific Departmental needs, such as the impact of new regulations on the commuter industry, or they may be yearly data-gathering requirements. These special studies are formulated to supply essential information not available from any other source.

Each on-going or recently completed FAA supporting study is described below. Should additional information be desired, FAA accession numbers are provided for each case where a report is available.

Airport Manager Reports

In order to obtain airport traffic data earlier than through existing channels, the FAA has instituted a program whereby selected airport managers voluntarily submit airport activity statistics directly to the FAA aviation forecasting group on a periodic basis. These reports enable the FAA to generate detailed breakdowns of traffic type not reported in standard publications.

State System Plans/Airport Master Plans

Through its Planning Grant Program, the FAA supports special on-site studies of specific airports by independent consultants. These studies generate detailed information on local socioeconomic conditions, and they form the foundation for locally derived forecasts required for airport master planning.

General Aviation Aircraft, Owner, and Utilization Characteristics (FAA-AVP-76-9)

This report, based on data collected for the FAA by the Bureau of the Census, presents the results of an extensive analysis of such factors as median and total hours flown, local and itinerant flight hours, cruising speed, avionics, and fleet distribution. The analysis was performed by FAA region, by use category, by type of aircraft, and by type of ownership.

General Aviation Activity at Nontowered Airports (1972 and 1974) (FAA-AVP-76-6)

This research project generated an automated data bank on nontowered airports, which handle about 90 percent of all general aviation activity. The data cover total and itinerant operations at 2,884 nontowered airports. It was used in revising the general aviation operations forecasting model.

Figure 24. Supporting Studies

S1. Airport Managers Reports
S2. State System Plans/Airport Master Plans
S3. Quick-Response Computer Tower Statistics
S4. General Aviation Time-of-Day Preference Study
S5. Fixed-Base Operator Study
S6. General Aviation Attrition Study
S7. General Aviation Aircraft, Owner and Utilization Characteristics
S8. General Aviation Activity at Nontowered Airports (1972 and 1974)
S9. United States General Aviation Cost Data
S10. Market Share Analysis
S11. Profiles of Air Carrier Activity
S12. Profiles of Air Cargo Operations
S13. Census Tract Data Base
S14. Atlantic Coast Basin Activity
S15. General Aviation Traffic Mix at High-Density Airports
S16. Regional General Aviation Dynamics
S17. Future Structural Changes in General Aviation Flying

United States General Aviation Cost Data

This computerized data base provides general aviation cost data from 1959 through 1976, and is used as the basis for making cost projections in FAA forecast models.

Market Share Analysis

The intermodal split of total passenger traffic and the potential share for air transportation will be analyzed by this study. It will incorporate such variables as travel distance and speed, fare structure, the availability of competing transport modes, passenger comfort, and the frequency of service. It will be useful in planning future expansion of the National Aviation System by the FAA.

Profiles of Air Carrier Activity

These publications depict the hourly distribution of scheduled air carrier traffic at major airports by type of carrier, type of equipment, and stage length. They are useful for analyzing airport capacity.

Profiles of Air Cargo Operations

These publications will depict the hourly distribution of scheduled air cargo traffic for individual airports. They will be useful in forecasting future markets and freight volumes, and for planning capacity requirements at specific airports.

Census Tract Data Base

This data base combines census tract demographic and socioeconomic data with an aviation data base. The resultant data base provides the FAA with the ability to analyze the geographic distribution of airports, aircraft and pilot population. These data are useful for airport planners and have proven invaluable when formulating FAA general aviation forecasts.

Atlantic Coast Basin Activity

Five-year forecasts of traffic across the North Atlantic are developed every two years. The forecasts cover both standard tracks across the North Atlantic and such new routes as the Caribbean to Northern Europe and North America to Africa. They are useful to the aviation industry, international airport managers, and the FAA for a wide spectrum of operational planning.

Quick Response Computer Tower Statistics (FAA-AVP-78-10)

Daily aircraft operations at all FAA-towered airports are available from on-line computer files for the years 1972 through the present. Included are operations for air carriers, air taxis, general aviation, and military aviation. These data provide a basis for peaking analysis and, as such, are valuable as an aid in short-term forcasting and airport planning. The FAA has scheduled a series of workshops that will instruct regional, state, and local planning authorities on procedures for accessing and manipulating these data banks.

General Aviation Time-of-Day Preference (FAA-AVP-77-21)

The hourly distribution of general aviation traffic at a major general aviation airport (Palo Alto, California) was analyzed in this study. This study is useful for evaluating airport capacity.

Fixed-Base Operators Study

Under contract to the FAA, the Bureau of the Census will survey the operators of approximately 2,000 randomly selected airports to ascertain the services provided by fixed-base operators. Since the types of services provided greatly influence airport growth, this study should aid planners in predicting growth at specific airports.

General Aviation Attrition Study (FAA- AVP-75-14)

This research project established the attrition rate of the general aviation fleet based upon type, age, and use of aircraft. Conclusions and data from this study are inputs to the FAA's general aviation fleet forecasting model.

General Aviation Traffic Mix at High-Density Airports

The changing patterns of general aviation activity versus air carrier operations at major airports will be analyzed by this study. It will be useful as an aid in planning future airport capacity and design.

Regional General Aviation Dynamics

The general aviation dynamic simulation forecasting model is being modified to incorporate unique regional determinants of growth. With this model, the impact of regional growth patterns on such variables as pilot population, general aviation operations, fleet size, and aircraft utilization can be evaluated. The model will be useful to regions in planning for general aviation growth.

Future Structural Changes in General Aviation Flying

In this study, the FAA will evaluate the impact on general aviation of such structural changes as new aircraft technology, attitude changes, and regulatory action. The results will be useful when analyzing the implications of policy actions on the National Aviation System and on the demand for general aviation aircraft and services.

National Aviation Activity Forecasts

Level 2 of Figure 20 displays the forecasts of national aviation activity that are now standard components of the FAA forecasting system. These forecasts fall basically into two groups. One group consists of forecasts of future activity in the air carrier, air taxi, general aviation, and military aviation sectors. These forecasts have been made by the FAA for many years and are the basic national aviation forecasts. National aviation forecasts in the second group are recent additions to the FAA forecasting system. They represent early steps in the FAA initiative to improve the decisionmaking utility of its forecasts and are now standard parts of the system.

Basic National Aviation Forecasts

Air Carriers: 12-year forecast of U.S. certified route air carrier scheduled enplanements, passenger miles, and operations; air freight (including air mail) operations, enplaned tons, and cargo ton miles; fleet size, composition, and utilization; domestic fuel consumption; and aircraft production.

Air Taxi: 12-year forecast of operations.

General Aviation: 12-year forecast of operations; fleet size, composition, and utilization; fuel consumption; and pilot population by type of certification.

Military Aviation: 12-year forecast of operations, fleet size, and utilization. Forecasts are based on information supplied by the Department of Defense and the United States Coast Guard.

Recent Additions

Supplemental Air Carriers: The FAA now forecasts both local and national activity by supplemental air carriers. This forecast is useful to local planners responsible for expansion at specific airports, to the air industry when planning fleet size and composition, and to the FAA in analyzing the impact of supplemental carriers on the National Aviation System.

International Air Carriers: These forecasts project worldwide aviation activity by world region, by aircraft type, and by altitude. World regional economic and population data, fuel prices, and aircraft operating costs are used as exogenous variables. These forecasts support studies on high-altitude pollution and the requirements for satellite communications.

Commuter Carriers: These 12-year forecasts cover both national and terminal area commuter airline activity. Forecasts are generated for passenger enplanments, operations, and fleet composition. This econometric forecasting model focuses on the service needs of small communities. The FAA can now evaluate the impact of such factors as regulatory reform, legislative change, and environmental restrictions. It is useful both for aircraft capacity analysis and policy evaluation.

General Aviation Dynamics: The primary objective of this analytical model is to ascertain how rising costs will affect growth in various segments of the general aviation industry. The impact of such events as regulatory reform, new taxes, legislative action, or an oil embargo on the cost structure of general aviation can be analyzed with this national dynamic simulation model. The model has been updated through 1976.

Operations at Towered Airports - Quarterly Forecasts: The FAA is now instituting an econometric forecasting model that will project the number of air carrier, air taxi, and general aviation operations at FAA-towered airports on a quarterly basis. The forecasts extend three years into the future and highlight seasonal variations in air traffic at individual terminals. These forecasts should prove particularly useful to the FAA for planning staffing levels at air traffic control stations, and to airport managers in planning the capacity requirements for individual airports.

Regional Aviation Activity Forecasts

General

Prior to 1978, the FAA generated regional aviation forecasts by disaggregating national-level totals. Consultation with the aviation community has shown that this approach alone does not cope with regional growth rates or conditions that differ substantially from the national average. The resulting forecasts sometimes prove to be of questionable use to aviation planners, except in those instances where regional growth parallels national growth.

In FY 1978, the FAA instituted fundamental changes in the process by which regional aviation forecasts are generated. The basic thrust of these changes was to involve regional and local officials both in gathering base data for the forecasts and in generating the forecasts themselves. Now, regional forecasts are based on regional socioeconomic conditions and trends and incorporate the perceptions of regional planners. These procedural changes are described in the FAA Forecasting Outreach Program.

Air Cargo Hub Area Forecasts

This econometric forecasting model projects air freight demand for 25 large U.S. hub areas for the years 1982 and 1987. It forecasts both air freighter operations and freight hauled in the holds of passenger aircraft. This forecasting model can be used to evaluate the potential impact of policy actions, regulatory reform, and legislative change.

Hub Area Forecasts

Detailed forecasts of the activity levels of domestic and international air carriers, air commuters, air taxis, general aviation, the military, and air cargo operations are generated periodically for the 25 major hub areas of the National Aviation System. These forecasts are based upon local socioeconomic projections and upon local aviation activity. They are useful when developing airport master plans, environmental impact statements, and for planning FAA facilities, staffing, and service levels. Selected hub area forecasts are now being distributed for a few locations. Others will follow as they are completed. Current plans call for periodic updates every three years.

General Aviation State Forecasts

In FY 1978, the FAA finalized an econometric model that forecasts specific state-level general aviation activity. Each forecast is generated using demographic and economic data gathered for the individual state. Previously, the FAA had disaggregated national aviation activity totals down to the state level when formulating state-level forecasts. Now the agency uses both this newly developed aggregation method and the disaggregation methodology used in previous years as a cross-check for consistency and accuracy. Differences will be resolved through an exchange of ideas and information between FAA and state officials.

The general aviation state forecasts provide annual forecasts of general aviation fleet size, aircraft utilization rates, and operations. The forecasts are structured to aid airport planning and development programs at both the state and local levels.

Local Aviation Activity Forecasts

General

A major thrust now underway at the FAA is to evolve the process by which forecasts for specific local sites are developed so as to incorporate local demographic and economic data more fully. In previous years, such forecasts were derived by disaggregation from national forecasts. While satisfying the overall management needs of the FAA, such disaggregated forecasts are not satisfactory for planning facility, equipment, and staffing levels at specific sites. These procedural changes are included in the section on the FAA Forecasting Outreach Program.

Terminal Area Forecasts

These forecasts project key aviation activity measures for 905 airports. They are prepared annually to meet the planning needs of FAA offices and services concerned with future traffic levels at these facilities. It includes national and regional summary tables and charts.

Air Route Traffic Control Center Forecasts

These annual forecasts project the number of IFR-aircraft departures and overs for the 24 FAA Air Route Traffic Control Centers. The forecasts are used for facility and budget planning.

Flight Service Station Forecasts

The FAA completed work on a new econometric model in FY 1978 that forecasts workload activity (the number of pilot briefs, flight plans filed, and aircraft contacted) for individual FAA flight service stations. Each forecast is generated using site-specific input data. The package of individual forecasts is then made consistent with national-level forecasts. These forecasts are used in planning for facility, equipment, and staffing requirements. They will be distributed for the first time this year and will be updated annually.

The FAA Forecasting Outreach Program

The FAA is evolving the procedures by which aviation forecasts are generated to achieve comprehensive interaction between all concerned aviation planners. The overall goal is to meld the talents and perceptions of regional, state, and local forecasters and planners, who have insight into such factors as area-specific growth patterns, with those of FAA-Headquarters forecasters, who are familiar with national trends and policies. Within the context of this basic goal, the agency hopes to achieve widespread agreement on baseline socioeconomic assumptions and inclusion of all relevant input data prior to issuing forecasts for particular hubs and airports.

The following are recent outreach initiatives or procedural changes instituted by the FAA to achieve its goal of improving FAA forecasts through consultation with national, regional, state and local forecasters. These initiatives are listed in Figure 25.

Figure 25. FAA Forecasting Outreach Initiatives

F1. Hub Forecast Workshops
F2. Forecast Seminars
F3. National Workshop for Regional Planners
F4. Regional Forecast Workshops
F5. Terminal Area Forecasts - Regional Review
F6. Terminal Area Forecasts - Data Access
F7. Consultations on Local Economic Statistics
F8. Interaction with Professional Air Industry Organizations
F9. Local Data Dissemination/Public Feedback

Hub Forecast Workshops

Working sessions are scheduled for major hub areas during preparation of each hub area forecast. The objective is to obtain widespread participation in the forecast-generating process by regional planners, airport operators, area governments, environmentalists, and the general public. A draft forecast is circulated to all concerned parties for final review prior to national publication.

Forecast Seminars

The FAA co-sponsors a series of seminars with selected universities each year to review in detail various forecasting topics of special interest. This year three such seminars were held. The focus at two of these was the current FAA effort to generate comprehensive forecasts for the Nation's 25 major hub areas. The topic of the Boston seminar in August of 1978 was general aviation forecasting. The discussion included comments on the weaknesses inherent in various data bases and forecast models, as well as the current initiatives to improve them.

Location/Date	Focus
Los Angeles, California February 1978, University of Southern California	Los Angeles Hub Forecast
Atlanta, Georgia May 1978, Georgia Tech	Atlanta Hub Forecast
Boston, Massachusetts August 1978, Massachusetts Institute of Technology	General Aviation Forecasting

National Workshop for Regional Planners

A workshop of major importance is planned for October 25, 1978, in conjunction with the Fourth Annual Aviation Forecast Review Conference. Personnel from every FAA region have been invited to meet in Washington, D.C., for a review of the schedule and procedures now in place by which regional and Headquarters personnel interact during the forecast-generating process. The objective of this workshop is to "fine-tune" this interaction to meet the requirements of all parties.

Regional Forecast Workshops

Several regional workshops were held in 1978, continuing the dialog between local aviation planners and forecasters at FAA Headquarters. Although a variety of topics were discussed at these workshops, the dominant issue at each was how the national forecasting process should evolve to meet planning needs at the regional, state, and local levels. For example, at the June workshop in Columbia, South Carolina, the national forecasting models were reviewed to determine if they could generate information of value to specific air terminals. The newly developed general aviation state forecast model was the dominant topic. On the other hand, the July workshop in Salem, Oregon, focused on the impact of aviation forecasts on the continuous planning process at the regional, state and local levels, and how this impact could be optimized in terms of timing and information content.

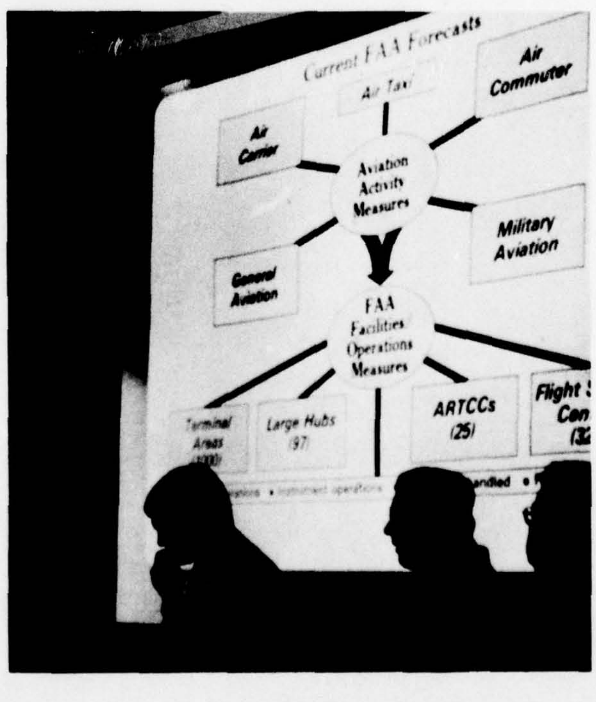
In the second half of 1978, FAA Headquarters personnel will visit eleven regions for a combination of purposes. Among these will be to review terminal area forecasts, and to instruct state and local planners on how to access and use FAA forecasting models and data bases. In addition, the FAA will seek to ascertain the data and forecasting requirements of specific locales, and will discuss topics of general interest to aviation planners such as the impact of proposed regulatory reform legislation.

Terminal Area Forecasts (TAF) - Regional Review

The FAA plans to institute annual regional reviews for its terminal area forecasts. These reviews will take place during January and February in each region. The objective is the transfer of locale-specific socioeconomic and demographic data to the FAA technicians responsible for generating the forecasts.

Terminal Area Forecasts (TAF) - Data Access

Closely associated with the annual regional reviews of the terminal area forecasts is a recent FAA initiative to standardize the software used in generating terminal area forecasts. Once equipped with this software package, regional planners will be able to obtain TAF data for any terminal area; adjust, change, or update the base year data; and feed the correct data back to FAA Headquarters. In this way, the FAA hopes to achieve input by regional and local planners into the base data for specific terminal area forecasts.



Consultations on Local Economic Statistics

The FAA has instituted a series of meetings with local officials in major cities to review economic projections for these localities by the Department of Commerce (Census Bureau). The objective of these meetings is to finalize data that can be used in generating both hub and terminal area forecasts. These meetings are now scheduled on an "ad hoc" basis. The following is the schedule of local consultations for FY 1978 and 1979.

CITY	MONTH
Houston, Texas	November 1977
Los Angeles, California	January 1978
Atlanta, Georgia	February 1978
Miami, Florida	July 1978
Tampa, Florida	August 1978
Dallas, Texas	August 1978
Honolulu, Hawaii	September 1978
Seattle, Washington	September 1978
Pittsburgh, Pennsylvania	October 1978
Philadelphia, Pennsylvania	October 1978
San Francisco, California	October 1978
Chicago, Illinois	October 1978
Denver, Colorado	December 1978

Interaction with Professional Air Industry Organizations

Each year, FAA personnel attend a variety of conferences and seminars sponsored by various organizations of the air industry. The goal is to maintain a continuing dialog with the managers and planners of the industry. Perceptions and ideas are exchanged in frank discussions and, ideally, a more accurate picture is reached as to the status of and prospects for the industry. The following are several such conferences that were attended in 1978.

Organization	Location/Date
Transportation Research Board	Washington, D.C. (January 1978)
National Association of State Aviation Officials	Lincoln, Nebraska (May 1978)
American Association of Airport Executives	Cincinnati, Ohio (May 1978)
Air Transport Association	Phoenix, Arizona (June 1978)
Air Transportation Research International Forum	Boston, Massachusetts (May 1978)
American Institute of Aeronautics and Astronautics	Los Angeles, California (August 1978)

Local Data Dissemination/Public Feedback

In order to promote widespread understanding and feedback on its work, the FAA publishes and distributes reports to the public on each of its basic forecasts. Besides predicting future aviation activity, these reports describe the methodology and assumptions that were employed. In addition, all FAA/University seminars are open to the public.

Chapter 5
Year-by-Year Data for FAA Aviation Forecasts, Fiscal Years 1979-1990

Chapter 5 provides summary data for the FAA FY 1979-90 Aviation Forecasts on a year-by-year basis.

- Tables 4 through 8 present forecasts of air carrier passenger and cargo traffic, fleet size, and hours and miles flown.
- Tables 9 through 11 are forecasts of general aviation fleet size and its use.
- Tables 12 and 13 provide the commuter air carrier forecasts for operations, enplanements, and passenger miles.
- Table 14 is a forecast of fuel consumption for the United States civil aviation fleet.
- Tables 15 and 16 show forecasts of the military fleet size and flying hours.
- Tables 17 through 25 display forecasts of the different measures of air traffic activity and workload at FAA tower, enroute, and flight service station facilities.
- Table 26 is a forecast of the number of active pilots by type of certificate.

Table 4 United States Certificated Route Air Carrier Scheduled Passenger Traffic

Fiscal	Revenue Passenger Enplanements (millions)			Revenue Passenger-Miles (billions)		
Year	Total	Domestic	International	Total	Domestic	International
Historical*						
1973	197.3	178.4	19.0	157.9	122.6	35.4
1974	208.1	189.5	18.6	165.0	130.0	35.0
1975	201.9	184.9	17.0	159.0	127.7	31.3
1976	211.8	195.1	16.7	169.5	137.3	32.2
1977	234.2	216.6	17.6	187.7	152.3	35.4
1978E	262.4	242.5	19.9	212.5	172.1	40.4
Forecast						
1979	287.3	265.5	21.8	233.7	189.3	44.4
1980	301.6	278.5	23.1	246.8	199.7	47.1
1981	313.3	289.2	24.1	257.7	208.5	49.2
1982	324.5	299.2	25.3	268.6	216.9	51.7
1983	339.2	312.6	26.6	282.3	227.9	54.4
1984	356.8	328.9	27.9	298.4	241.1	57.3
1985	371.8	342.2	29.6	312.9	252.2	60.7
1986	385.8	354.6	31.2	327.1	262.8	64.3
1987	399.7	366.8	32.9	341.1	273.3	67.8
1988	415.6	380.9	34.7	357.1	285.3	71.8
1989	434.4	397.8	36.6	375.3	299.6	75.7
1990	453.9	415.6	38.3	394.1	314.6	79.5

E Estimate *Source: CAB Air Carrier Traffic Statistics.
Prior to 1977, the fiscal year ended on June 30.
Detail may not add to total due to independent rounding.

Table 5 U.S. Air Cargo Traffic(1) All Services at U.S. Airports(2)

Calendar Year	Revenue Cargo Enplaned Tons(3) (thousands) Total	U.S. Domestic	International	Revenue Cargo Ton-Miles(4) (millions) Total	U.S. Domestic	International
Historical*						
1973	—	3,623	—	—	3,662	—
1974	4,356	3,427	929	9,480	3,632	5,848
1975r	3,999	3,182	817	9,051	3,470	5,581
1976r	4,242	3,379	863	9,820	3,664	6,156
1977r	4,604	3,587	1,017	10,828	3,947	6,881
1978E	4,936	3,842	1,094	11,691	4,258	7,433
Forecast						
1979	5,272	4,092	1,180	12,685	4,650	8,035
1980	5,579	4,308	1,271	13,650	4,967	8,683
1981	5,860	4,493	1,367	14,627	5,253	9,374
1982	6,107	4,635	1,472	15,622	5,488	10,134
1983	6,462	4,872	1,590	16,815	5,851	10,964
1984	6,831	5,116	1,715	17,882	6,223	11,659
1985	7,183	5,333	1,850	19,413	6,584	12,829
1986	7,584	5,586	1,998	20,873	6,991	13,882
1987	7,963	5,805	2,158	22,384	7,360	15,024
1988	8,407	6,076	2,331	24,072	7,807	16,265
1989	8,878	6,359	2,519	25,890	8,280	17,610
1990	9,380	6,657	2,723	27,856	8,784	19,072

E Estimate r Revised *Source: CAB Air Carrier Traffic Statistics and U.S. Department of Commerce, Bureau of the Census

(1) Includes Freight Express and Mail
(2) Includes scheduled and nonscheduled service of all U.S. and Foreign Flag Carriers
(3) Exports only
(4) Includes Imports plus Exports

Table 6 Total Aircraft in the Service of United States Air Carriers

(As of January 1)

Aircraft Type	Reported 1978*	Forecast 1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total Aircraft	**2495**	**2532**	**2581**	**2620**	**2668**	**2716**	**2764**	**2811**	**2859**	**2907**	**2954**	**3002**	**3049**
Fixed-wing Aircraft	**2492**	**2528**	**2577**	**2615**	**2663**	**2710**	**2758**	**2805**	**2852**	**2900**	**2947**	**2994**	**3041**
Jet	**2188**	**2240**	**2310**	**2366**	**2432**	**2497**	**2563**	**2622**	**2692**	**2762**	**2824**	**2891**	**2960**
2-engine	563	583	643	703	769	836	906	940	970	995	1012	1035	1069
3-engine	1074	1129	1178	1210	1230	1258	1277	1316	1356	1387	1416	1451	1476
4-engine	551	528	489	453	433	403	380	366	366	380	396	405	415
Turboprop	**239**	**229**	**217**	**207**	**197**	**187**	**177**	**167**	**148**	**128**	**115**	**97**	**81**
2-engine	176	172	166	160	154	148	142	136	120	103	93	77	61
4-engine	63	57	51	47	43	39	35	31	28	25	22	20	20
Piston	**65**	**59**	**50**	**42**	**34**	**26**	**18**	**16**	**12**	**10**	**8**	**6**	**0**
1- and 2-engine	32	29	26	24	22	20	18	16	12	10	8	6	—
4-engine	33	30	24	18	12	6	—	—	—	—	—	—	—
Helicopter	**3**	**4**	**4**	**5**	**5**	**6**	**6**	**6**	**7**	**7**	**7**	**8**	**8**

*Source: FAA Aircraft Utilization and Propulsion Reliability Report

Included here are all passenger and cargo aircraft owned or leased by, and in the domestic or international service of the United States certificated route, supplemental, intrastate, and commercial air carriers. Aircraft used for training and aircraft that have been withdrawn from service and are awaiting disposal are not included here. Aircraft in the service of air taxi operators are shown in the general aviation aircraft fleet on another page of this report.

Table 7 Total Airborne Hours, United States Air Carriers

By Fiscal Year (Millions)

	Estimated	Forecast											
Aircraft Type	**1978***	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Total Aircraft	6.39	**6.49**	**6.64**	**6.75**	**6.88**	**7.03**	**7.16**	**7.29**	**7.44**	**7.61**	**7.75**	**7.90**	**8.04**
Fixed-wing Aircraft	6.38	**6.48**	**6.63**	**6.74**	**6.87**	**7.02**	**7.15**	**7.28**	**7.43**	**7.60**	**7.74**	**7.89**	**8.03**
Jet	5.91	**6.03**	**6.21**	**6.35**	**6.51**	**6.68**	**6.83**	**6.98**	**7.17**	**7.37**	**7.54**	**7.71**	**7.89**
2-engine	1.41	1.45	1.61	1.76	1.92	2.09	2.26	2.35	2.42	2.49	2.53	2.59	2.67
3-engine	2.97	3.12	3.25	3.34	3.39	3.47	3.52	3.62	3.74	3.83	3.91	4.00	4.07
4-engine	1.53	1.46	1.35	1.25	1.20	1.12	1.05	1.01	1.01	1.05	1.10	1.12	1.15
Turboprop	.42	**.40**	**.38**	**.36**	**.34**	**.32**	**.31**	**.29**	**.25**	**.22**	**.19**	**.17**	**.14**
2-engine	.30	.29	.28	.27	.26	.25	.24	.23	.20	.17	.15	.13	.10
4-engine	.12	.11	.10	.09	.08	.07	.07	.06	.05	.05	.04	.04	.04
Piston	.05	**.05**	**.04**	**.03**	**.02**	**.02**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**—**
1- and 2-engine	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	—
4-engine	.03	.03	.02	.02	.01	.01	—	—	—	—	—	—	—
Helicopter	.01	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**	**.01**

*Source: FAA Aircraft Utilization and Propulsion Reliability Report
Included here are hours flown by all passenger and cargo aircraft that are owned or leased by and are in the domestic or international service of the United States certificated route, supplemental, intrastate, and contract air carriers.

Table 8 Total Statute Miles, United States Air Carriers

By Fiscal Year (Millions)

	Estimate	Forecast											
Aircraft Type	**1978***	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Total Aircraft	2625	**2659**	**2724**	**2771**	**2827**	**2891**	**2946**	**3002**	**3067**	**3141**	**3202**	**3265**	**3327**
Fixed-wing Aircraft	2624	**2658**	**2723**	**2770**	**2826**	**2890**	**2945**	**3001**	**3066**	**3140**	**3201**	**3264**	**3326**
Jet	2518	**2565**	**2636**	**2689**	**2752**	**2820**	**2879**	**2939**	**3013**	**3093**	**3160**	**3227**	**3297**
2-engine	529	544	610	671	736	807	877	913	935	957	967	984	1012
3-engine	1277	1341	1397	1436	1457	1492	1513	1556	1608	1647	1681	1720	1750
4-engine	712	680	629	582	559	521	489	470	470	489	512	523	535
Turboprop	96	**83**	**79**	**75**	**70**	**66**	**64**	**60**	**51**	**45**	**39**	**35**	**29**
2-engine	68	58	56	54	52	50	48	46	40	34	30	26	20
4-engine	28	25	23	21	18	16	16	14	11	11	9	9	9
Piston	10	**10**	**8**	**6**	**4**	**4**	**2**	**2**	**2**	**2**	**2**	**2**	**—**
1- and 2-engine	4	4	4	2	2	2	2	2	2	2	2	2	—
4-engine	6	6	4	4	2	2	—	—	—	—	—	—	—
Helicopter	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

*Source: FAA Aircraft Utilization and Propulsion Reliability Report
Included here are miles flown by all passenger and cargo aircraft owned or leased by, and in the domestic or international service of the United States certificated route, supplemental, intrastate, and contract air carriers.

Table 9 Estimated Active General Aviation Aircraft by Type of Aircraft

(In Thousands)

As of January 1	Total	Fixed Wing: Piston, Single-Engine	Fixed Wing: Piston, Multi-Engine	Fixed Wing: Turboprop	Fixed Wing: Turbojet	Rotorcraft	Balloons Dirigibles Gliders
Historical*							
1973	145.0	120.4	17.3	1.5	1.1	2.8	1.9
1974	153.5	126.2	18.7	1.9	1.4	3.1	2.3
1975	161.5	131.9	19.8	2.1	1.6	3.6	2.5
1976	168.5	136.9	20.3	2.5	1.8	4.1	2.8
1977	178.3	144.9	21.3	2.5	1.9	4.5	3.2
1978E	186.6	151.2	22.4	2.8	2.1	4.7	3.4
Forecast							
1979	198.8	160.6	24.1	3.2	2.3	5.0	3.6
1980	208.6	167.8	25.4	3.7	2.6	5.3	3.8
1981	219.6	176.3	26.8	4.0	2.9	5.6	4.0
1982	230.0	184.2	28.3	4.3	3.1	5.8	4.3
1983	240.4	192.3	29.6	4.6	3.4	6.1	4.4
1984	251.1	200.4	31.1	4.9	3.6	6.4	4.7
1985	261.9	208.6	32.5	5.2	3.9	6.7	5.0
1986	272.4	216.7	33.8	5.6	4.2	6.9	5.2
1987	282.5	224.2	35.3	5.9	4.5	7.2	5.4
1988	292.1	231.4	36.5	6.4	4.8	7.4	5.6
1989	301.6	238.3	37.7	6.9	5.1	7.7	5.9
1990	310.8	245.0	38.9	7.4	5.4	8.0	6.1

E Estimate *Source: FAA Statistical Handbook of Aviation.
Detail may not add to total because of independent rounding.
An active aircraft must have a current registration and it must have been flown during the previous calendar year.

Table 10 Estimated Active General Aviation Aircraft by FAA Region

(In Thousands)

As of January 1	Total	FAA Region ANE	AEA	ASO	AGL	ACE	ASW	ARM	AWE	ANW	AAL	APC
Historical*												
1973	145.0	5.3	18.6	21.1	28.1	10.6	19.5	7.6	22.8	7.9	3.0	.3
1974	153.5	5.5	19.8	23.2	29.1	11.1	20.7	7.9	24.0	8.3	3.3	.3
1975	161.5	6.2	21.2	24.4	30.7	11.6	21.7	8.3	25.1	8.6	3.4	.3
1976	168.5	6.4	21.2	24.9	31.0	12.3	23.1	9.3	25.9	9.8	4.2	.3
1977	178.3	6.4	21.7	26.2	32.6	13.3	24.2	10.0	27.5	11.0	4.7	.4
1978E	186.6	6.8	22.6	28.0	33.5	13.6	26.4	10.3	28.6	11.5	4.9	.4
Forecast												
1979	198.8	7.2	24.0	29.2	35.9	14.9	27.0	11.8	30.7	12.3	5.3	.5
1980	208.6	7.5	25.0	30.8	37.5	15.6	28.4	12.7	32.1	12.9	5.6	.5
1981	219.6	7.9	26.3	32.4	39.2	16.5	30.0	13.5	33.8	13.6	5.9	.5
1982	230.0	8.2	27.6	33.9	41.0	17.3	31.5	14.2	35.3	14.3	6.2	.5
1983	240.4	8.6	28.8	35.4	42.7	18.2	33.0	14.8	36.9	15.0	6.5	.5
1984	251.1	9.0	30.1	37.0	44.4	19.0	34.4	15.6	38.5	15.7	6.8	.6
1985	261.9	9.2	31.4	38.6	46.2	19.9	36.1	16.3	40.1	16.4	7.1	.6
1986	272.4	9.5	32.6	40.2	48.0	20.7	37.6	17.0	41.7	17.1	7.4	.6
1987	282.5	9.9	33.8	41.6	49.7	21.6	39.0	17.7	43.2	17.7	7.7	.6
1988	292.1	10.2	34.9	42.9	51.3	22.2	40.5	18.3	44.7	18.3	8.1	.7
1989	301.6	10.5	35.9	44.2	53.0	23.0	41.9	18.9	46.1	19.0	8.4	.7
1990	310.8	10.9	37.0	45.5	54.5	23.6	43.2	19.5	47.6	19.6	8.7	.7

E Estimate *Source: FAA Statistical Handbook of Aviation.
Detail may not add to total due to independent rounding.
Totals include a small number of aircraft located in foreign countries. Also see Table 9 footnotes.

Table 11 Estimated Hours Flown in General Aviation by Type of Aircraft

(In Millions)

		Fixed Wing					
		Piston					
Fiscal Year	Total	Single-Engine	Multi-Engine	Turboprop	Turbojet	Rotorcraft	Balloons Dirigibles Gliders
Historical*							
1973	28.5	20.8	4.7	1.1	.6	1.1	.2
1974	31.3	22.5	5.2	1.2	.8	1.3	.4
1975	33.3	23.9	5.4	1.3	.8	1.5	.4
1976	35.1	25.4	5.5	1.3	.9	1.7	.3
1977	36.7	26.1	6.0	1.4	1.0	1.8	.4
1978E	38.6	27.2	6.4	1.6	1.1	1.9	.4
Forecast							
1979	41.4	29.1	6.8	1.8	1.2	2.0	.5
1980	43.6	30.4	7.2	2.0	1.4	2.1	.5
1981	46.2	32.1	7.6	2.2	1.5	2.3	.5
1982	48.6	33.5	8.1	2.4	1.7	2.3	.6
1983	51.0	35.2	8.4	2.5	1.8	2.5	.6
1984	53.6	36.7	8.9	2.7	2.0	2.6	.7
1985	56.0	38.4	9.3	2.8	2.1	2.7	.7
1986	58.5	39.9	9.7	3.0	2.3	2.8	.8
1987	60.8	41.3	10.1	3.2	2.5	2.9	.8
1988	62.9	42.6	10.5	3.4	2.6	3.0	.8
1989	65.3	43.8	10.9	3.7	2.8	3.2	.9
1990	67.4	45.1	11.2	3.9	3.0	3.3	.9

E Estimate *Source: *FAA Statistical Handbook of Aviation.*
Prior to 1977, the fiscal year ended on June 30.
Detail may not add to total because of independent rounding.

Table 12 Commuter Airlines Aircraft Operations

(In millions)

Calendar Year	Current Points*	Puerto Rico	Trans- fers	New Points	Total
Historical*					
1973	1.5	.3	—	—	1.8
1974	1.7	.3	—	—	2.0
1975	1.9	.3	—	—	2.2
1976E	2.1	.3	—	—	2.4
1977E	2.5	.3	—	—	2.8
1978E	2.8	.3	—	—	3.1
Forecast					
1979	3.0	.3	.1	.1	3.5
1980	3.1	.3	.1	.1	3.6
1981	3.2	.4	.2	.2	4.0
1982	3.2	.4	.2	.3	4.1
1983	3.3	.4	.3	.4	4.4
1984	3.5	.4	.3	.4	4.6
1985	3.5	.4	.4	.4	4.7
1986	3.6	.5	.5	.4	5.0
1987	3.8	.5	.5	.4	5.2
1988	3.8	.5	.6	.4	5.3
1989	4.0	.5	.6	.4	5.5
1990	4.1	.5	.6	.4	5.6

E Estimate *Source: Civil Aeronautics Board
Based on a passenger boarding factor of 5.0 in 1976 increasing to 6.0 in 1990.

Table 13 Commuter Airlines Passenger Traffic[1]

Calendar Year	Revenue Passenger Enplanements (Millions) Current Points[2]	Puerto Rico	Transfers[3]	New Points[4]	Total	Revenue Passenger Miles (Millions) Current Points	Puerto Rico	Transfers[5]	New Points[5]	Total
Historical*										
1973	3.9	1.1	—	—	5.0	434.2	79.5	—	—	513.7
1974	4.8	1.2	—	—	6.0	552.8	80.9	—	—	633.7
1975	4.7	1.1	—	—	5.8	537.8	74.5	—	—	612.3
1976	5.2	1.0	—	—	6.2	593.6	72.1	—	—	665.7
1977	6.4	1.0	—	—	7.4	766.3	70.2	—	—	836.5
1978E	7.2	1.0	—	—	8.2	871.2	70.4	—	—	941.6
Forecast										
1979	7.9	1.1	.1	.1	9.3	963.8	77.0	12.2	12.2	1,065.2
1980	8.2	1.1	.2	.3	9.8	1,008.6	77.2	24.6	36.9	1,147.3
1981	8.6	1.2	.3	.4	10.5	1,066.4	84.2	37.2	49.6	1,237.4
1982	8.9	1.3	.4	.6	11.2	1,112.5	91.3	50.0	75.0	1,328.8
1983	9.2	1.3	.5	.7	11.7	1,159.2	91.3	63.0	88.2	1,401.7
1984	9.7	1.4	.7	.8	12.6	1,231.9	98.3	88.9	101.6	1,520.7
1985	10.1	1.5	.8	.8	13.2	1,292.8	105.3	102.4	102.4	1,602.9
1986	10.5	1.6	1.0	.8	13.9	1,354.5	112.3	129.0	103.2	1,699.0
1987	10.9	1.6	1.1	.8	14.4	1,417.0	112.6	143.6	104.0	1,776.6
1988	11.3	1.7	1.3	.9	15.2	1,480.3	119.0	170.3	117.9	1,887.5
1989	11.8	1.7	1.4	.9	15.9	1,557.6	119.3	184.8	118.8	1,980.5
1990	12.3	1.8	1.5	.9	16.5	1,635.9	126.4	199.5	119.7	2,081.5

E Estimate *Source: Civil Aeronautics Board

Detail may not add to total due to independent rounding.

[1] 48 contiguous states plus Puerto Rico.

[2] Enplanements at current points, exclusive of Puerto Rico.

[3] Based on 74 mainland certificated cities enplaning less than 40 passengers daily. These cities were grouped in the same categories used for existing exclusive commuter points and the corresponding models used to derive estimates of enplanements at these new points. The estimates were then doubled to represent enplanements at the corresponding hubs, and phased in over five years beginning in 1979.

[4] Based on 50 potential new mainland service points. The forecast methodology is similar to that used for the transfer points, the phase-in period is ten years.

[5] Based on same average trip lengths as for current points.

Table 14 Estimated Fuel Consumed by United States Domestic Civil Aviation

(In millions of gallons)

Fiscal Year	Total Jet Fuel and Aviation Gasoline	Jet Fuel			Aviation Gasoline		
		Total	Air Carrier	General Aviation	Total	Air Carrier	General Aviation
Historical*							
1973r	9,135	8,703	8,399	304	432	21	411
1974r	8,783	8,320	7,963	357	463	20	443
1975r	8,745	8,313	7,860	453	432	20	412
1976r	8,769	8,317	7,822	495	452	20	432
1977	9,396	8,921	8,385	536	475	19	456
1978E	9,770	9,279	8,669	610	491	17	474
Forecast							
1979	10,141	9,618	8,964	654	523	15	508
1980	10,567	10,024	9,284	740	543	13	530
1981	10,966	10,392	9,598	794	574	11	563
1982	11,412	10,803	9,925	878	609	9	600
1983	11,822	11,185	10,262	923	637	7	630
1984	12,265	11,600	10,613	987	665	7	658
1985	12,711	12,013	10,985	1,028	698	6	692
1986	13,225	12,468	11,374	1,094	757	5	752
1987	13,736	12,950	11,772	1,178	786	5	781
1988	14,178	13,364	12,138	1,226	814	4	810
1989	14,778	13,937	12,609	1,328	841	4	837
1990	15,265	14,397	12,987	1,410	868	4	864

E Estimate r Revised *Source: FAA AVP Estimates

Prior to 1977, the fiscal year ended on June 30.

Domestic civil aviation is defined for purposes of the table to include all civil aircraft flights which originate and terminate within the 50 states. Estimates of fuel consumed by airframe and aircraft engine manufacturers, whether for flight testing or ground testing, are not shown here because they are not available for domestic industry as a whole and estimates cannot be developed with any assurance of accuracy. Estimates of fuel consumed by the supplemental, contract and intrastate carriers are included in the "Air Carrier" columns. It should also be noted that general aviation fuel consumption is not reported and historical series are estimates.

Table 15 Active U.S. Military Aircraft in Continental United States(1)

Fiscal Year	Total	Fixed Wing Aircraft Jet	Turboprop	Piston	Helicopter
Historical*					
1973	21,727	9,344	1,223	2,989	8,171
1974	21,143	9,091	1,207	2,854	7,991
1975	19,889	9,526	1,298	1,927	7,138
1976	19,775	9,255	1,511	1,360	7,649
1977	18,670	9,168	1,382	1,075	7,045
1978E	18,801	9,247	1,491	897	7,166
Forecast					
1979	18,527	9,167	1,517	652	7,191
1980	18,714	9,418	1,548	552	7,196
1981	18,761	9,573	1,527	457	7,204
1982	18,721	9,600	1,508	419	7,194
1983	18,778	9,648	1,511	417	7,202
1984	18,709	9,589	1,520	399	7,201
1985	18,687	9,545	1,515	396	7,231
1986(2)	18,721	9,547	1,499	395	7,280
1987	18,721	9,547	1,499	395	7,280
1988	18,721	9,547	1,499	395	7,280
1989	18,721	9,547	1,499	395	7,280
1990	18,721	9,547	1,499	395	7,280

E Estimate *Source: Office of the Secretary of Defense, Department of Defense.
Prior to 1977, the fiscal year ended June 30.
(1) Includes Army, Air Force, Navy and Marine regular service aircraft, as well as Reserve and National Guard aircraft.
(2) Detailed planning information not available beyond 1986. 1987-1990 projected at 1986 level.

Table 16 Active U.S. Military Aircraft Flying Hours in Continental United States(1)

(in thousands)

Fiscal Year	Total	Fixed Wing Aircraft Jet	Turboprop	Piston	Helicopter
Historical*					
1973	7,381	3,785	524	1,108	1,964
1974	6,403	3,287	533	1,051	1,532
1975	6,510	3,478	677	902	1,453
1976	5,928	3,109	646	559	1,614
1977	5,401	2,932	577	489	1,403
1978E	5,487	2,970	579	504	1,434
Forecast					
1979	5,694	3,057	590	494	1,553
1980	5,697	3,117	584	459	1,537
1981	5,736	3,178	578	444	1,536
1982	5,706	3,199	536	437	1,534
1983	5,689	3,195	528	433	1,533
1984	5,691	3,198	526	434	1,533
1985	5,687	3,193	527	433	1,534
1986(2)	5,697	3,203	527	434	1,533
1987	5,697	3,203	527	434	1,533
1988	5,697	3,203	527	434	1,533
1989	5,697	3,203	527	434	1,533
1990	5,697	3,203	527	434	1,533

E Estimate *Source: Office of the Secretary of Defense, Department of Defense.
Prior to 1977, the fiscal year ended June 30.
(1) Includes Army, Air Force, Navy and Marine regular service aircraft, as well as Reserve and National Guard Aircraft.
(2) Detailed planning information not available beyond 1986. 1987-1990 projected at 1986 level.

Table 17 Total Itinerant and Local Aircraft Operations at Airports with FAA Traffic Control Service

(In millions)

Fiscal Year	Total	Itinerant	Local	Number of Towers
Historical*				
1973	53.9	34.0	19.9	362
1974	56.8	36.1	20.8	394
1975	59.0	37.6	21.4	416
1976	62.5	39.7	22.8	423
1977	66.7	42.4	24.3	427
1978E	66.7	42.9	23.8	432
Forecast				
1979	71.3	45.4	25.9	437
1980	75.6	48.0	27.6	442
1981	79.4	50.5	28.9	447
1982	82.9	53.0	29.9	452
1983	85.7	55.0	30.7	457
1984	88.6	56.9	31.7	462
1985	91.1	58.7	32.4	467
1986	93.2	60.3	32.9	472
1987	95.2	61.9	33.3	477
1988	97.1	63.3	33.8	482
1989	98.8	64.5	34.3	487
1990	100.2	65.7	34.5	492

E Estimate *Source: FAA Air Traffic Activity.
Detail may not add to total due to independent rounding.
Prior to 1977, the fiscal year ended June 30.
An aircraft operation is defined as an aircraft arrival at or a departure from an airport with FAA traffic control service. A local operation is performed by an aircraft that: operates in the local traffic pattern or within sight of the tower; is known to be departing for or arriving from flight in local practice areas; or executes simulated instrument approaches or low passes at the airport. All aircraft arrivals and departures other than local (as defined above) are classified as itinerant operations.

Table 18 Itinerant Aircraft Operations at Airports with FAA Traffic Control Service

(In millions)

Fiscal Year	Total	Air Carrier	Air Taxi	General Aviation	Military
Historical*					
1973	34.0	9.8	2.1	20.6	1.5
1974	36.1	9.5	2.4	22.9	1.3
1975	37.6	9.4	2.7	24.2	1.3
1976	39.7	9.3	2.9	26.2	1.3
1977	42.4	9.8	3.3	28.1	1.3
1978E	42.9	10.1	3.5	28.1	1.2
Forecast					
1979	45.4	10.4	4.0	29.8	1.2
1980	48.0	10.7	4.4	31.7	1.2
1981	50.5	10.9	4.9	33.5	1.2
1982	53.0	11.1	5.3	35.4	1.2
1983	55.0	11.4	5.7	36.7	1.2
1984	56.9	11.6	6.3	37.8	1.2
1985	58.7	11.8	6.7	39.0	1.2
1986	60.3	12.0	7.1	40.0	1.2
1987	61.9	12.3	7.5	40.9	1.2
1988	63.3	12.5	7.9	41.7	1.2
1989	64.5	12.7	8.1	42.5	1.2
1990	65.7	12.9	8.4	43.2	1.2

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30.
Detail may not add to total due to independent rounding.
See Table 17 for definition of itinerant operations.
Air taxi includes commuter.

Table 19 Local Aircraft Operations at Airports with FAA Traffic Control Service

(In millions)

Fiscal Year	Total	General Aviation	Military
Historical*			
1973	19.9	18.1	1.8
1974	20.8	19.3	1.5
1975	21.4	20.0	1.4
1976	22.8	21.4	1.4
1977	24.3	22.9	1.4
1978E	23.8	22.5	1.3
Forecast			
1979	25.9	24.6	1.3
1980	27.6	26.3	1.3
1981	28.9	27.6	1.3
1982	29.9	28.6	1.3
1983	30.7	29.4	1.3
1984	31.7	30.4	1.3
1985	32.4	31.1	1.3
1986	32.9	31.6	1.3
1987	33.3	32.0	1.3
1988	33.8	32.5	1.3
1989	34.3	33.0	1.3
1990	34.5	33.2	1.3

E Estimate *Source: FAA Air Traffic Activity
Prior to 1977, the fiscal year ended on June 30.
Detail may not add to total due to independent rounding.
See Table 17 for definition of local operations.

Table 20 Instrument Operations at Airports with FAA Traffic Control Service

(In millions)

Fiscal Year	Total	Air Carrier	Air Taxi	General Aviation	Military
Historical*					
1973	22.5 (1.5)	9.8	1.1	7.4	4.2
1974	24.1 (2.6)	9.5	1.4	9.2	4.0
1975	26.2 (2.9)	9.5	1.9	10.8	4.0
1976	28.1 (6.2)	9.5	2.2	12.8	3.7
1977	31.5 (7.4)	10.0	2.6	15.2	3.8
1978E	32.7 (7.4)	10.5	2.9	15.7	3.6
Forecast					
1979	34.4 (7.5)	10.8	3.3	16.7	3.6
1980	36.8 (7.7)	11.0	3.7	18.5	3.6
1981	38.3 (7.8)	11.2	3.9	19.6	3.6
1982	39.4 (7.9)	11.4	4.1	20.3	3.6
1983	40.6 (8.0)	11.7	4.3	21.0	3.6
1984	41.5 (8.0)	11.9	4.5	21.5	3.6
1985	43.1 (8.1)	12.1	4.6	22.8	3.6
1986	45.1 (8.1)	12.3	5.0	24.2	3.6
1987	47.4 (8.2)	12.6	5.5	25.7	3.6
1988	49.9 (8.3)	12.8	6.0	27.5	3.6
1989	50.9 (8.3)	13.0	6.3	28.0	3.6
1990	52.0 (8.4)	13.3	6.6	28.5	3.6

E Estimate *Source: FAA Air Traffic Activity

Prior to 1977, the fiscal year ended June 30.

An *instrument operation* is defined as the handling by an FAA terminal traffic control facility of the arrival, departure, or overflight at an airport of an aircraft on an IFR flight plan or the provision of IFR separation to other aircraft by an FAA terminal traffic control facility. Non-IFR *instrument* counts at Terminal Control Area (TCA) facilities and Stage III of expanded area radar service are included in the totals and noted in parenthesis as an information item (see Table 21).

The data include instrument operations at FAA-operated military radar approach control facilities.

Air taxi includes commuter.

Table 21 Non-IFR Instrument Operations

(In millions)

Fiscal Year	Total	Terminal Control Areas—TCA's	Expanded Area Radar Service Stage III As of 6/30/75	Expanded Area Radar Service Stage III After 7/1/75
Historical*				
1973	1.5	—	1.5	—
1974	2.6	—	2.6	—
1975	2.9	—	2.9	—
1976	6.2	1.7	3.7	.8
1977	7.4	2.0	4.2	1.2
1978E	7.4	2.0	4.2	1.2
Forecast				
1979	7.5	2.1	4.2	1.2
1980	7.7	2.2	4.3	1.2
1981	7.8	2.3	4.3	1.2
1982	7.9	2.4	4.3	1.2
1983	8.0	2.4	4.4	1.2
1984	8.0	2.4	4.4	1.2
1985	8.1	2.5	4.4	1.2
1986	8.1	2.5	4.4	1.2
1987	8.2	2.5	4.4	1.3
1988	8.3	2.5	4.5	1.3
1989	8.3	2.5	4.5	1.3
1990	8.4	2.6	4.5	1.3

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30.
TCA count not available prior to 1976.

Table 22 IFR Aircraft Handled FAA Air Route Traffic Control Centers

(In millions)

Fiscal Year	Total			Aircraft Handled			
	Aircraft Handled	IFR Departures	Overs	Air Carrier	Air Taxi	General Aviation	Military
Historical*							
1973	22.8	8.9	5.1	12.6	.9	4.6	4.7
1974	22.9	9.0	4.9	12.4	1.1	5.1	4.3
1975	23.6	9.3	5.1	12.4	1.3	5.5	4.4
1976	23.9	9.4	5.1	12.4	1.4	6.0	4.2
1977	26.0	10.2	5.6	13.0	1.6	6.9	4.5
1978E	28.1	11.1	5.9	13.6	1.9	8.2	4.4
Forecast							
1979	29.7	11.8	6.1	14.1	2.3	8.9	4.4
1980	31.1	12.4	6.3	14.3	2.7	9.7	4.4
1981	32.5	13.0	6.5	14.6	2.9	10.6	4.4
1982	34.0	13.6	6.8	14.9	3.3	11.4	4.4
1983	35.4	14.2	7.0	15.2	3.7	12.1	4.4
1984	36.9	14.9	7.1	15.4	4.1	13.0	4.4
1985	38.4	15.5	7.4	15.7	4.3	14.0	4.4
1986	39.7	16.1	7.5	16.0	4.5	14.8	4.4
1987	41.4	16.8	7.8	16.5	5.0	15.5	4.4
1988	42.8	17.4	8.0	16.8	5.4	16.2	4.4
1989	44.2	18.0	8.2	17.1	5.6	17.1	4.4
1990	45.6	18.6	8.4	17.4	5.8	18.0	4.4

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30.
Detail may not add to total due to independent rounding.
The aircraft handled count consists of the number of IFR departures multiplied by two plus the number of overs. This concept recognizes that for each departure there is a landing. An IFR departure is defined as an original IFR flight plan filed either prior to departure or after becoming airborne. An overflight originates outside the ARTCC area and passes through the area without landing. The forecast data assume present operating rules and procedures. Air taxi includes commuter.

Table 23 IFR Departures and Overs FAA Air Route Traffic Control Centers

(In millions)

	Air Carrier		Air Taxi		General Aviation		Military	
Fiscal Year	IFR Departures	Overs	IFR Departures	Overs	IFR Departures	Overs	IFR Departures	Overs
Historical*								
1973	4.7	3.2	.4	0	2.0	.6	1.7	1.2
1974	4.6	3.1	.5	0	2.2	.7	1.6	1.1
1975	4.6	3.1	.6	.1	2.4	.7	1.6	1.2
1976	4.6	3.2	.7	.1	2.6	.8	1.5	1.1
1977	4.8	3.4	.8	.1	3.0	.9	1.6	1.2
1978E	5.0	3.6	.9	.1	3.6	1.0	1.6	1.2
Forecast								
1979	5.2	3.7	1.1	.1	3.9	1.1	1.6	1.2
1980	5.3	3.7	1.3	.1	4.2	1.3	1.6	1.2
1981	5.4	3.8	1.4	.1	4.6	1.4	1.6	1.2
1982	5.5	3.9	1.6	.1	4.9	1.6	1.6	1.2
1983	5.6	4.0	1.8	.1	5.2	1.7	1.6	1.2
1984	5.7	4.0	2.0	.1	5.6	1.8	1.6	1.2
1985	5.8	4.1	2.1	.1	6.0	2.0	1.6	1.2
1986	5.9	4.2	2.2	.1	6.4	2.0	1.6	1.2
1987	6.1	4.3	2.4	.2	6.7	2.1	1.6	1.2
1988	6.2	4.4	2.6	.2	7.0	2.2	1.6	1.2
1989	6.3	4.5	2.7	.2	7.4	2.3	1.6	1.2
1990	6.4	4.6	2.8	.2	7.8	2.4	1.6	1.2

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30. Air taxi includes commuter.

Table 24 Total Flight Services, Pilot Briefs and Flight Plans Originated at FAA Flight Service Stations and Combined Station/Towers

(In millions)

Fiscal Year	Total Flight Services	Pilot Briefs	Flight Plans Originated		
			Total	IFR-DVFR	VFR
Historical*					
1973	53.7	14.7	7.2	4.5	2.7
1974	56.2	15.4	7.8	5.0	2.8
1975	58.3	16.2	8.0	5.2	2.8
1976	58.2	16.1	8.1	5.4	2.7
1977	61.3	16.9	8.7	5.9	2.8
1978E	65.8	18.2	9.4	6.4	3.0
Forecast					
1979	72.9	20.2	10.7	7.5	3.2
1980	80.1	22.7	11.7	8.3	3.4
1981	86.4	24.9	12.5	9.0	3.5
1982	92.8	27.2	13.3	9.7	3.6
1983	99.3	29.6	14.1	10.4	3.7
1984	105.4	31.8	14.9	11.1	3.8
1985	110.8	33.7	15.7	11.8	3.9
1986	116.0	35.5	16.5	12.5	4.0
1987	120.9	37.2	17.3	13.2	4.1
1988	125.1	38.8	17.9	13.8	4.1
1989	129.9	40.6	18.6	14.4	4.2
1990	134.5	42.3	19.3	15.1	4.2

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30.
Detail may not add to total due to independent rounding.
Total Flight Services is a weighted workload measurement derived by multiplying pilot briefs and flight plans originated by two and adding the number of aircraft contacted. A flight plan may be filed orally or in writing to qualify for inclusion in the activity count. The data forecast in Tables 24 and 25 are based upon the current number of an configuration of the FSS and CS/T. Any change in their number or operation would have a corresponding change on the forecast.

Table 25 Aircraft Contacted, FAA Flight Service Stations and Combined Station/Towers

(In millions)

Fiscal Year	Total	IFR-DVFR	VFR	Air Carrier	Air Taxi	General Aviation	Military
Historical*							
1973	9.9	1.5	8.4	.6	.7	8.0	.7
1974	9.9	1.5	8.4	.4	.7	8.1	.7
1975	10.0	1.6	8.4	.4	.7	8.1	.7
1976	9.8	1.5	8.3	.4	.8	8.0	.6
1977	10.2	1.7	8.5	.4	.8	8.4	.6
1978E	10.6	1.9	8.7	.5	.9	8.6	.6
Forecast							
1979	11.1	2.0	9.1	.5	1.3	8.7	.6
1980	11.3	2.1	9.2	.5	1.4	8.8	.6
1981	11.6	2.2	9.4	.5	1.5	9.0	.6
1982	11.8	2.2	9.6	.5	1.5	9.2	.6
1983	11.9	2.2	9.7	.5	1.6	9.2	.6
1984	12.0	2.2	9.8	.5	1.6	9.3	.6
1985	12.0	2.2	9.8	.5	1.6	9.3	.6
1986	12.0	2.1	9.9	.5	1.5	9.4	.6
1987	11.9	2.0	9.9	.5	1.5	9.3	.6
1988	11.7	1.9	9.8	.5	1.4	9.2	.6
1989	11.5	1.8	9.7	.5	1.4	9.0	.6
1990	11.3	1.7	9.6	.5	1.4	8.8	.6

E Estimate *Source: FAA Air Traffic Activity.
Prior to 1977, the fiscal year ended June 30.
Detail may not add to total due to independent rounding.
Aircraft contacted represent a record of the number of aircraft with which FAA facilities (FSS, CS/T) have established radio communications contact. One count is made for each enroute, landing or departing aircraft contacted by a facility, regardless of the number of contacts with an individual aircraft. A flight involving contacts with five different facilities, disregarding the number of contacts with each, would be counted as five aircraft contacted. Air taxi includes commuter.

Table 26 Active Pilots by Type of Certificate

(thousands)

As of January 1	Total	Students	Private	Commercial	Airline Transport	Helicopter	Glider	Other	Instrument Rated[1]
Historical*									
1973	750.9	181.5	321.4	196.2	37.7	8.0	4.1	2.0	188.0
1974	714.6	181.9	298.9	182.4	38.1	6.0	4.3	3.0	186.0
1975	733.7	180.8	305.8	192.4	41.0	5.6	4.8	3.2	199.3
1976	728.2	177.0	305.9	189.3	42.6	4.9	5.3	3.1	204.0
1977	744.2	188.8	309.0	187.8	45.1	4.8	5.8	3.0	211.4
1978	783.9	203.5	327.4	188.8	50.1	4.8	6.2	3.0	226.3
Forecast									
1979	844.1	214.7	363.6	198.8	52.3	4.7	7.0	3.0	241.9
1980	899.7	222.3	387.4	220.1	54.4	4.7	7.8	3.0	265.2
1981	941.5	227.8	407.1	234.0	56.5	4.6	8.5	3.0	287.2
1982	970.1	227.9	421.4	245.6	58.5	4.6	9.1	3.0	306.1
1983	987.0	225.4	430.0	254.0	60.3	4.6	9.7	3.0	324.6
1984	1,008.6	228.2	441.7	259.0	62.0	4.5	10.2	3.0	341.7
1985	1,038.8	231.8	459.2	265.8	63.8	4.5	10.7	3.0	358.3
1986	1,064.2	231.2	474.8	276.1	63.5	4.5	11.1	3.0	375.8
1987	1,088.5	229.6	487.2	285.2	67.3	4.6	11.6	3.0	393.2
1988	1,107.6	227.2	499.2	292.5	69.0	4.6	12.1	3.0	408.7
1989	1,131.3	227.2	513.7	299.5	70.6	4.6	12.7	3.0	423.5
1990	1,155.8	225.0	529.6	308.1	72.2	4.7	13.2	3.0	438.4

*Source: FAA Statistical Handbook of Aviation.
Detail may not add to total due to independent rounding.
[1]Should not be added to other categories in deriving total.
The total count includes all pilots with current medical certificates; it also includes pilots who no longer fly but desire to keep their active status by periodic medical examinations. At the close of 1973 the active pilot count totalled 714,607, compared with 750,869 at the end of 1972. The decrease in the number of airmen resulted from a purging of the Airmen Certification files. During this process approximately 26,000 duplicates of faulty records were eliminated.
Helicopter pilots include pilots who hold only a helicopter certificate.

Appendix A
Forecast Comparisons

Table A-1 compares the 1978 FAA aviation forecasts with those made in 1977. Although the forecasts are similar, this section provides explanations for those variations that have developed. Comparisons are made for representative aircraft activity parameters and for indicators of the FAA operations workload. Forecasts are compared for 3 years.

- 1978: To compare the 1977 forecast values with actual preliminary 1978 values for each aviation category.
- 1983: To highlight forecast changes that could affect FAA near-future budgetary actions on manpower, facilities and equipment.
- 1989: To indicate perceived changes in the long-term evolution of aviation activity.

Aviation Activity: Air carrier passenger activity is now forecast to grow more rapidly than predicted last year, due basically to increased vacation flying as a result of discount options now being introduced by the airlines. Air cargo, on the other hand, is now expected to show weaker gains, due primarily to an expected higher rate of increase in operating costs. It should also be noted that the 1975-1977 air cargo data used last year were estimates that proved to be higher than the actual numbers. The 1978 forecast for the general aviation (GA) fleet is slightly lower for 1983 and slightly higher for 1989, but overall the forecasts remain basically consistent with those of 1977. In the short-term, hours flown by general aviation are predicted to be lower than the forecasts of hours flown made in 1977, due primarily to the impact of higher fuel costs on GA local flying. However, in the long-term, the forecasts of hours flown made in 1978 are higher than those made in 1977. This reflects increases in the forecast of the GA fleet and assumed increases in its utilization rate. Forecasts of the military aviation fleet are slightly lower than in 1977. However, forecasts of military hours flown are virtually the same.

FAA Workload Measures: As indicated in Table A-1 the forecasts of FAA workload measures in the September 1978 publication differ slightly from those presented in the September 1977 forecasts. The preliminary estimates for aircraft operations in 1978 are lower than that

Table A-1
Forecast Comparisons

(September 1978 versus September 1977)

Aviation Activity Forecasts

Air Carriers	Enplanements (Millions)			Revenue Passenger Miles (Billions)		
Year/Forecast	1977	1978	Percent Change	1977	1978	Percent Change
1978	248.1	262.4*	+5.8	200.1	212.5*	+6.2
1983	320.2	339.2	+5.9	265.6	282.3	+6.3
1989	418.4	434.4	+3.8	359.3	375.3	+4.5
Air Cargo	Revenue Cargo Tons (Thousands)			Revenue Cargo Ton Miles (Millions)		
Year/Forecast	1977	1978	Percent Change	1977	1978	Percent Change
1978	5,549	4,936*	−11.0	13,196	11,691*	−11.4
1983	7,127	6,462	−10.3	18,863	16,815	−10.9
1989	9,887	8,878	−10.2	28,484	25,890	− 9.1
General Aviation	Total Aircraft (Thousands)			Hours Flown (Millions)		
Year/Forecast	1977	1978	Percent Change	1977	1978	Percent Change
1978	186.6	186.6*	0	39.3	38.6*	−1.8
1983	244.8	240.4	−1.8	51.5	51.0	0
1989	291.3	301.6	3.5	60.1	65.3	+8.7
Military Aviation	Total Aircraft			Hours Flown (Thousands)		
Year/Forecast	1977	1978	Percent Change	1977	1978	Percent Change
1978	19,641	18,801*	−4.3	5,778	5,487*	− 5.0
1983	19,584	18,778	−4.1	5,662	5,689	+0.5
1989	19,577	18,721	−4.4	5,662	5,697	+0.6

FAA Workload Measures

Aircraft Operations (Millions)			
Year/Forecast	1977	1978	Percent Change
1978	71.6	66.7*	−6.8
1983	88.4	85.7	−3.1
1989	99.0	98.8	−0.2
Instrument Operations (Millions)			
Year/Forecast	1977	1978	Percent Change
1978	32.3	32.7*	+1.2
1983	40.1	40.6	+1.2
1989	50.4	50.9	+1.0
IFR Aircraft Handled (Millions)			
Year/Forecast	1977	1978	Percent Change
1978	27.1	28.1*	+3.7
1983	34.6	35.4	+2.3
1989	41.5	44.2	+6.5
Flight Services (Millions)			
Year/Forecast	1977	1978	Percent Change
1978	65.1	65.8*	+1.1
1983	94.5	99.3	+5.1
1989	121.9	129.9	+6.6

*Preliminary estimates

forecast in 1977 primarily because of a decline in GA local aircraft operations. The decline in GA local operations is due mainly to increases in cost of fuel, unusually bad flying conditions stemming from snow, rain, and low temperatures during last winter and spring, and restrictions on general aviation flying in congested airspace.

The current forecast of aircraft operations at FAA towered airports for 1989 is not significantly different from that made in September 1977. However, IFR aircraft handled at air route traffic control centers and flight services at flight service stations are about 6.5 percent higher than the numbers previously forecast for 1989. The increases reflect the higher growth of the general aviation fleet, higher anticipated utilization rates associated with GA aircraft, and increased use of avionics.

Appendix B
Macro Air Carrier Forecasting Model

July 1978

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I. Introduction

In its long-range planning, the FAA is concerned about utilization of the National Aviation System (NAS) as well as its future capability to make improvements in the system. This appendix discusses a model which forecasts the contribution of the scheduled U.S. flag air carriers, both to the workload of the FAA and to the aviation trust fund.

The expected use of the FAA air traffic system by the air carriers and their contribution to development funds depend primarily on the amount of passenger traffic handled by the carriers and on the operating behavior of the airlines. The model describes the historical relationships between economic activity and air carrier passenger traffic, aircraft operations, and passenger revenues, for both domestic and international markets. These relationships are extrapolated into the future, based on assumptions of "likely" airline behavior and general economic conditions, to form the basis of the forecasts of passenger traffic, air carrier operations, and passenger revenues.

The remainder of this paper is divided into four parts. In Section II, the structure of the model is reviewed and in Section III the *a priori* assumptions are discussed. The statistical results are presented in Section IV. In the final section there is a discussion of the economic assumptions that form the basis of the forecasts of air carrier activities.

II. Model Structure

The model discussed here is an extension of research presented in Appendix B of *FAA Aviation Forecasts, Fiscal Years 1978-1989***. As in the previous work, demand for air transportation services as measured by revenue passenger miles (RPM) and passenger enplanements (ENP) is hypothesized to be related to price, income, and quality of air carrier service. Due to some specification problems with last year's model, a slightly different set of variables was used. In addition, a model for international passenger traffic was developed.

The forecasts of passenger demand, coupled with airline operating constraints such as the load factor and aircraft seating capacity, determine the number of air carrier flights. This demand, combined with the

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*Ira Gershkoff is an employee of the Onyx Corporation and developed the model while under contract to FAA.

average air fare, provides an estimate of the revenues received by the air carriers. Trust fund receipts can be calculated from domestic revenues (currently 8 percent of revenues) and international enplanements (currently $3 per passenger). The equations and variables used to describe these relationships are presented in Box A and Box B respectively.

III. A Priori Expectations

The equations for domestic RPM's and enplanements have been formulated as typical economic demand functions. YIELD represents the price variable; it should be negatively correlated with RPM and ENP, the two quantity variables. PP represents the price of a substitute service. Consumers always have the option of driving their cars instead of flying, but as the costs of operating a motor vehicle increase relative to the cost of flying, air transportation becomes more attractive. This coefficient should therefore have a positive sign. YPD is the income variable; as real personal income increases, more of it is allocated for air travel, so this variable will therefore have a positive coefficient as well.

NRUT (unemployment rate) takes into account two effects. First: Given a constant labor force, if the unemployment rate rises the pool of potential travelers decreases. Second: The unemployment rate may have a negative psychological impact on many who are employed. In times of high unemployment, many individuals become financially more conservative and might tend to cut back on nonessentials such as travel, particularly air travel.

The dummy variable DUM69 accounts for the understatement of RPM's and enplanements prior to 1969 due to the treatment of flights to Alaska and Hawaii as international. The coefficient of DUM69 should have a negative sign. STR is another dummy variable which accounts for losses in traffic due to strikes; it should also have a negative sign.

Due to the nature of the markets and the data, the international equations for RPM's and enplanements have fewer variables. The data go back only to 1969, and there have been no major strikes since then, so DUM69 and STR are not necessary. There is no need for a substitute good variable because for international travel there is no substitute to air transport, for all practical purposes.

The other variables (price, income and unemployment) should influence international air travel in the same manner that they do in the domestic sector, but there is the problem of which country's data to use in the estimations. U.S. citizens are still the predominant international air travelers, but their "market share" is declining. Since traffic only on U.S. carriers is being counted and revenue is ultimately converted to dollars, it was felt appropriate to use the U.S. yield as the price variable. However, a composite GNP variable was created by converting the quarterly GNP figures of Britain, Germany, and Japan to U.S. dollars at the exchange rates prevailing at each period and adding them up. These countries represent the three largest aviation trade partners of the United States.

By the same reasoning, there is the problem of what to use for a price deflator on these economic variables. This is complicated by the paradox that during the early to mid-1970's the United States had a lower inflation rate, yet a declining exchange rate with these countries. As a result, the GNP and yield variables were used in undeflated terms. For similar reasons, no unemployment rate was used.

As a regulated industry, airline yields should grow proportionately with average costs in the long run. Yields should be positively related to labor costs (WBCRG$, wage rate in regulated industry) and fuel costs (PDCENG, oil and gas deflator). On the other hand, a higher average trip length will tend to push yields down. This happens because long trips are more efficient on a per mile basis than shorter ones. These factors apply equally to both domestic and international flights.

The model as described here is simultaneous and its solution is nonlinear. For both the domestic and international sectors, the RPM's and enplanements are functions of the yield; the yield is a function of trip length; and the trip length is the ratio of RPM's to enplanements. This represents four simultaneous equations in our unknowns:

$$RPM = a + b*YIELD$$
$$ENP = c + d*YIELD$$
$$YIELD = e + f*TRIPLN$$
$$TRIPLN = RPM/ENP$$

The constants a, b, c, d, e, and f represent aggregations of all other variables of this model that are exogenous to this system. This system is solved by substituting the first, second, and fourth equations into the third. The result is a quadratic equation in which one of the two solutions is correct and the other is pathological: i.e., results in negative values of RPM and/or ENP.

IV. Statistical Results

The simultaneous aspect of the model requires the use of two-stage least squares for those equations where the dependent variable is a linear function of other dependent variables in the model. In this case, both domestic and international RPM's and enplanements are linear functions of the corresponding yield. The yield, however, is a nonlinear function of RPM's and enplanements; therefore, ordinary least squares was used for the estimations of domestic and international yield.

On the other hand, the yield equations did show some positive serial correlation, as judged from their low (0.287 and 1.286) Durbin-Watson statistics. A first order correction was applied and found to be sufficient; no second order serial correlation was found to be present.

Box A

Macro Air Carrier Model Equations

Domestic

(1) $RPM = f_1$ (YIELD, PP, YPD, NRUT, DUM69, STR)

(2) $ENP = f_2$ (YIELD, PP, YPD, NRUT, DUM69, STR)

(3) $YIELD = f_3$ (PDCENG, WBCRG$, TRIPLN)

(4) $$TRIPLN = \frac{RPM * 1000}{ENP}$$

(5) $$REV = \frac{RPM * YIELD}{100}$$

(6) $$OPS = \frac{2 * 100000 * 1.0366 * RPM}{LOAD * SEATS * STAGE}$$

International

(7) $IRPM = f_4$ (IYIELD, BIG4GNP)

(8) $IENP = f_5$ (IYIELD, BIG4GNP)

(9) $IYIELD = f_6$ (PDCENG, ITRIPLN)

(10) $$ITRIPLN = \frac{IRPM * 1000}{IENP}$$

(11) $$IREV = \frac{IRPM * IYIELD}{100}$$

Totals

(12) TRPM = RPM + IRPM

(13) TENP = ENP + IENP

(14) TREV = REV + IREV

(15) TRUST = 1000 * 0.08 * REV + 3 * IENP

Box B

Definitions of Macro Air Carrier Model Variables.

The variable names used in the model are defined below and presented in alphabetical order. All variables are stored on a quarterly basis. Domestic variables range from 1964 to 1977; international variables from 1969 to 1977. All variables are taken from the CAB publication *Air Carrier Traffic Statistics,* unless otherwise noted.

BIG4GNP—Sum of the gross national products of the United States, United Kingdom, Germany and Japan. The latter three nations represent the three largest aviation trading partners of the United States. Foreign GNPs are converted to dollars at the prevailing exchange rate of the time and summed. Source: Wharton Econometric Forecasting Associates.

CPI—Consumer price index (1972 = 100). This variable was used as the price deflator. Source: Wharton Econometric Forecasting Associates (PC*).

DUM69—A dummy variable. This variable has a value of 1 from 1964 to 1968 and 0 from 1969 onward. Prior to 1969, flights to Hawaii and Alaska were counted as international. Since Hawaii traffic is a significant fraction of the total, this variable is necessary to explain the discontinuity in the domestic data resulting from the accounting change.

ENP—Scheduled U.S. certificated route air carrier revenue passenger enplanements, seasonally adjusted (see Box C). This variable represents millions of passengers boarding scheduled domestic flights.

IENP—Scheduled international revenue passenger enplanements, seasonally adjusted. Data are in millions of passengers.

IREV—Scheduled international passenger revenues, in billions of dollars. Source: CAB, *Air Carrier Financial Statistics.*

IRPM—Scheduled international revenue passenger miles seasonally adjusted. Revenue passenger miles represent the overall demand for air travel. An RPM is counted when one paying passenger flies one mile. The data are in billions of RPM's.

ITRIPLN—Average trip length for international passengers. This variable represents the average distance an individual flies on one aircraft on one trip. To illustrate, a passenger boarding at Point A and going to Point B with three stops is flying one trip. However, a passenger changing planes at intermediate Stop C is counted as two trips. As a result, the trip length as calculated in the first case is twice that of the second. ITRIPLN is expressed in miles.

IYIELD—Average revenue per passenger mile on international flights. IYIELD is calculated by dividing total international revenues by total international RPM's. It represents a weighted average of scheduled passenger fares, including first class, coach, excursion and other discount fares. IYIELD is expressed in cents per passenger mile.

LOAD—Average revenue load factor on domestic flights. This is defined as the ratio of domestic revenue passenger miles to available seat miles and is a measure of capacity utilization for the air carriers. As the utilization rate increases, the number of aircraft operations is expected to decrease.

Equations 1-3 and 7-9 represent structural linear relationships in which the variables in the right-hand side of the equations cause or explain the behavior of those on the left-hand side. All the other equations are identities describing definitional relationships among those variables calculated inside the model (endogenous variables) and those calculated outside the model (exogenous variables). The sum of domestic and international figures give the totals found in equations 12-15.

Factors of 1000 or some other power of ten appearing in the identity equations above represent units adjustments. For example, in equation (5) above, revenue should equal RPMs multiplied by yield. RPM is expressed in billions and YIELD is expressed in cents per RPM; therefore, the product is billions of cents. To convert to billions of dollars we divide by 100. Similar rationale is behind the other power of ten adjustments.

In the equation for domestic operations (6), the right-hand side expression, RPM/(LOAD * SEATS * STAGE),represents departures. The factor of 2 represents two operations for every departure, and the 100,000 is a units adjustment. The factor of 1.0366 represents adjustments for foreign flag, supplemental, and intrastate carriers, that are reflected in the operations data but not in the RPM data. The adjustment factor to balance the left and right sides of the equation varied from 2½ to 4 percent of the operations over the historical period, averaging 3.66 percent; this is the figure used in all runs of the model.

NEHT—Civilian employment, in millions. Source: Wharton.

NRUT—Unemployment rate, in percent. This is the familiar figure issued by the Bureau of Labor Statistics. Source: Wharton.

OPS—Millions of air carrier operations. This figure includes foreign flag, supplemental and intrastate operations. Source: *FAA Air Traffic Activity*.

PDCENG—Oil and gas price deflator. This index represents the relative price of oil and gas products (1972 = 100).

PP—Price index of private transportation (1972 = 100). This represents the cost of owning, operating and maintaining a motor vehicle. Source: Bureau of Labor Statistics.

REV—Revenues on scheduled domestic passenger service, in billions of dollars. Source: CAB, *Air Carrier Financial Statistics.*

RPM—Scheduled U.S. certificated route air carrier revenue passenger miles, seasonally adjusted. The data are in billions of RPM's.

SEATS—Average number of available seats per aircraft, domestic flights. This item is growing over time due to the substitution of wide-body aircraft for narrow. All other things equal, an increase in SEATS will result in a decrease in operations.

STAGE—Average stage length for domestic flights, in miles. This is not to be confused with TRIPLN, the average passenger trip length. STAGE is calculated by dividing aircraft miles by departures. As STAGE increases, the number of aircraft operations is expected to decline.

STR—Dummy variable for strikes. This variable was used to estimate the effect of major airline strikes on the demand for air travel. The period most affected by a strike was the third quarter of 1966. The variable is one during this period and zero otherwise.

TENP—Total revenue passenger enplanements, domestic and international.

TREV—Total passenger revenues, domestic plus international. Source: CAB, *Air Carrier Financial Statistics*.

TRIPLN—Average trip length for domestic passengers. It is analogous to ITRIPLN for the domestic sector.

TRPM—Total revenue passenger miles, domestic plus international.

TRUST—Trust fund receipts, in millions of dollars. Contributions from both domestic and international operations are included.

WBCRG$—Index of the wage rate in regulated industries (1972 = 100).

YIELD—Average revenue per passenger mile on domestic flights. It is calculated by dividing domestic passenger revenues by domestic RPM's. As in the international case, it represents a weighted average of all scheduled passenger fare plans.

YPD—Disposable personal income, in constant 1972 dollars. This variable is indicative of the real purchasing power available to be spent on aviation.

In the results of regressions for the domestic air carrier model below, the range of the data used was quarterly from 1964Q1 to 1977Q4. T-statistics are shown in parentheses.

(1) RPM = −10.5747 − 4.4444*YIELD/CPI
(−1.31) (−6.26)
+ 19.8679*PP/CPI + 0.05683*YPD
(3.34) (14.59)
−0.29075*NRUT − 4.40053*STR
(−2.56) (−5.14)
−2.27622*DUM 69
(−4.59)

Corrected R-squared	=	0.989
Durbin-Watson Statistic	=	1.518
Standard Error	=	0.830
Dependent Mean	=	26.076

Instrumental variables: DUM69, NEHT, NRUT, PDCENG(−1), PP/CPI, STR, WBCRG$(−1), YPD

(2) ENP = −7.43114 − 6.55014*YIELD/CPI
(−0.646) (−6.450)
+ 30.8618*PP/CPI + 0.07395*YPD
(3.624) (13.278)
−0.77733*NRUT − 6.72588*STR
(− 4.796) (−5.490)
−3.04467*DUM69
(−4.298)

Corrected R-squared	=	0.987
Durbin-Watson Statistic	=	1.471
Standard Error	=	1.187
Dependent Mean	=	39.947

Instrumental variables: same as RPM equation.

(3) YIELD = 8.09096 − 0.00803445*TRIPLN
(15.022) (−11.341)
+ 0.0110173*PDCENG(−1) +
(2.510)
0.0473187*WBCRG$(−1)
(5.728)

Corrected R-squared	=	0.988
Durbin-Watson Statistic	=	1.783
Standard Error	=	0.277
Dependent Mean	=	6.461
Rho	=	0.882

Note that all coefficients are of expected sign, substantiating the *a priori* hypotheses. The t-statistics indicate that all coefficients (other than the constant terms) are significantly different from zero at a 95 percent confidence level, and nearly all are significant at the 99 percent level. Moreover, the corrected R-squares indicate that the independent variables explain over 98 percent of the variance in the dependent variables.

The price elasticities for the RPM and ENP equations, calculated at the mean, were found to be 0.89 and 0.86, respectively. Income elasticities for these equations were higher, 1.65 for RPM and 1.40 for ENP.

As discussed previously, two-stage least squares was used for equations (1) and (2) above. This is necessary to prevent any statistical errors in YIELD from compounding into the forecasts for RPM and ENP. The proper procedure is first to regress YIELD on the list of instrumental variables. In this case, the list of instrumental variables included all exogenous variables used in the model. The resulting fitted values of YIELD are used as right-hand side data in the regressions of RPM and ENP.

Equation (3) above was run with a first order autocorrelation correction. This version retains the high explanatory power of the uncorrected estimation (not shown). In addition, the Durbin-Watson statistic indicates that the correction procedure has virtually eliminated the first order serial correlation. The value of rho shows how the estimation error in one time period is dependent on the error in the previous time period. Specifically,

$$e_t = u_t + rho{*}e_{t-1}$$

where e_t is the estimation error for the current time period, u_t is random, or stochastic, error for the current time period, and e_{t-1} is the error for the estimate of YIELD in the previous time period.

The international equations as shown below did not fit as well as the corresponding domestic equations. The same statistical techniques were used, however; two-stage least squares was used for IRPM and IENP, and a first order autoregressive correction was applied to the equation for IYIELD. The data were quarterly from 1969Q1 to 1977Q4.

(4) IRPM = 9354.45 − 1227.96*IYIELD
(21.982) (−9.210)
+ 2.7438*BIG4GNP
(13.351)

Corrected R-squared	=	0.881
Durbin-Watson Statistic	=	1.451
Standard Error	=	310.94
Dependent Mean	=	8051.59

Instrumental variables: BIG4GNP, NEHT, NRUT, PDCENG (−1), PP/CPI, WBCRG$ (−1)

(5) IENP = 5536.05 − 582.356*IYIELD
(33.760) (−11.335)
+ 1.02572*BIG4GNP
(12.932)

Corrected R-squared	=	0.852
Durbin-Watson Statistic	=	1.483
Standard Error	=	119.82
Dependent Mean	=	4305.73

Instrumental variables: same as IRPM equation

$$\text{(6)}\quad IYIELD = \underset{(5.32048)}{2.90872} - \underset{(-1.84742)}{0.000624661} * ITRIPLN + \underset{(18.0791)}{0.0342251} * PDCENG(-1)$$

Corrected R-squared	= 0.964
Durbin-Watson Statistic	= 1.826
Standard Error	= 0.199
Dependent Mean	= 6.028
Rho	= 0.350

Again, all coefficients are of the expected sign. In (6), however, the coefficient on ITRIPLN is not quite significant at the 5 percent level. The high t-statistic of the coefficient on PDCENG, relative to the other coefficients, shows how dominant fuel prices have been in determining international yields since 1969. Price elasticities for the IRPM and IYIELD equations were 0.87 and 0.79, respectively. Income elasticities were 0.72 and 0.50. One reason the elasticities are much lower for income in the international equations is that the income variable is undeflated.

V. Forecast Assumptions

Forecasts from the Wharton Econometric Forecasting Associates, Inc., are the source of the baseline economic assumptions used in this model. The baseline scenario assumes in general that the economic recovery that began in 1975 will continue through 1979, but with a more moderate growth in GNP in 1978 and 1979 (4.2 percent) than in previous years. Over the forecast period, annual growth for real GNP is expected to average approximately 3.2 percent, reduced slightly from the 3.5 percent forecast last year. A recession, though certainly possible, is not foreseen until 1980-82, after which real GNP growth should grow at a nominal 3 percent to 3½ percent rate. This is less than the historical average due to the recent declines in population and productivity growth that are expected to continue.

The increase in personal disposable income anticipated throughout the forecast period will encourage consumer spending. However, personal consumption of services is not expected to increase as rapidly as GNP. Consumption patterns are expected to shift toward the purchase of fuel and fuel-efficient durable goods. As this becomes more important, the proportion of GNP spent on services such as air transportation is expected to decline. Inflation, as measured by the consumer price index, is expected to be 6.7 percent in 1979 and 7.3 percent in 1980, followed by slowly declining rates averaging 6.0 percent through 1990.

Slower increases in employment are anticipated than in recent years, where strong growth, mainly due to the entrance of large numbers of women into the labor force, was observed. Employment growth is expected to be 2.4 percent annually over the next two years, and decreasing to between 1.9 percent and 1.5 percent annually during the 1980's. An average growth rate of slightly under 1.6 percent is expected between 1980 and 1990, but the size of the labor force will be expanding more in line with population growth of 1.0 percent to 1.5 percent. Accordingly, unemployment rates are forecast to decline steadily during the period, reaching approximately 4 percent by 1990.

Fuel costs are expected to rise 6.2 percent annually throughout the forecast period as a result of price increases by the Organization of Petroleum Exporting Countries (OPEC) and domestic oil producers. This projection does not include increases that might occur if domestic taxes were imposed on aviation fuel. The baseline forecast assumes that fuel usage will not be restricted by forces other than price. These price increases are about the same as the general inflation rate.

In addition to these economic assumptions, some assumptions about airline behavior were made. Because of continuing increases in operating costs, the air carriers will attempt to remain profitable by maintaining load factors while increasing their use of wide-body aircraft. This policy will enable the airlines to increase the number of seats flown on each market, while maintaining flight frequencies and reducing cost per seat-mile. Finally, the substitution of commuter service in some short-haul markets and the introduction of more nonstop service are expected to cause the average length to increase gradually during the forecast period. Based on these factors and historical trends, forecast value for load factor, seats per aircraft, and stage lengths were determined exogenously by AVP-120 staff.

Proposed regulatory reform now in the legislative process is designed to strengthen competitive market forces within the air carrier industry. Entry and expansion into existing and new markets would be facilitated, as would abandonment of unprofitable routes. Proposed regulatory reform would also provide carriers with greater discretion in fare-setting, encourage commuter service to small communities, and allow commuter carriers to operate larger aircraft. The ad-hoc reforms currently instituted have already been a significant stimulus to the tourist sector of aviation markets. If the discount fares prove to be successful for both the consumer and the airline industry, they are certain to continue.

Because the yield equations were estimated over a time period in which there was relatively much less discounting than there is currently, an adjustment to take this into account was felt to be necessary. In the forecast simulations, the model was first run in the usual way. The results for both domestic and international yield were then discounted 10 percent for 1978 and 15 percent for 1979 onward. This represents an estimate, based on the limited data currently available, of the decline in yield that will result from travelers taking advantage of the discount fares. On the domestic side, there was a further discount of 2 percent per year beginning in 1980 to reflect the increase in productivity resulting from the substitution of wide-body aircraft for conventional aircraft. The model was then rerun using these yield numbers instead of the structural equations for yield. This procedure removes the simultaneity from the model and therefore makes it much easier to solve. The forecasts of air carrier activities are the result of this second stage of the simulation process and are not simultaneous.

Generally, the economic assumptions used in the baseline forecast are more pessimistic than those used in the previous forecast. Real income growth is lower and inflation higher than last year's assumptions. These negative effects are dampened by expectations of lower fares and increased productivity in the airline industry in the 1980's. The overall effect of these contradictory forces leaves the baseline passenger demand forecasts substantially unchanged from those presented in September 1977. The operations forecast, also basically unchanged, shows a very slow growth in operations. This results from the substitution of wide-body for narrow-body aircraft offsetting the relatively rapid growth in RPM's.

Box C

Calculation of Seasonal Adjustments

Much of the data has been seasonally adjusted using the X-11 method as developed by the Bureau of the Census. This method was implemented as follows. First, a centered, nonseasonal moving average series was created from the original quarterly series using the equation:

$$X_{NS_t} = \frac{X_t(-2)}{8} + \frac{X_t(-1)}{4} + \frac{X_t}{4} + \frac{X_t(+1)}{4} + \frac{X_t(+2)}{8}$$

This series is centered because the weights (factors of ⅛ and ¼) are symmetric about the current period. This implies that the means of X_t and X_{NS_t} are indentical. It is nonseasonal because all four quarters have equal weight.

(The terms $\frac{X_t(-2)}{8}$ and $\frac{X_t(+2)}{8}$ represent the same quarter in consecutive years, and their weights add to ¼. Therefore, all four quarters have weights of ¼.) The ratio X_t/X_{NS_t} will yield a series of seasonal factors centering around 1; for the airline industry they will be greater than 1 for the peak 2nd and 3rd quarters and less than 1 for the off-peak 1st and 4th quarters.

To obtain a single set of seasonal adjustment factors, the next step is to calculate the average of X_t/X_{NS_t} for each quarter. An idea of statistical significance can be obtained by regressing $(X_t/X_{NS_t}-1)$ versus four seasonal dummy variables. This will yield coefficients centered around zero, and t-statistics can then be compared. Using this method, 1 must be added to the coefficients to obtain the seasonal factors. The product of the four seasonal factors should be very close to 1.

To seasonally adjust data, the original series is simply divided by the calculated seasonal factor for each quarter. The reverse procedure is used for deseasonalizing simulation results.

Appendix C

Seasonal Models and Forecasts for Aggregate Aircraft Operations at FAA Towered Airports

July 1978

George Wang*
Elaine McCarthy*

Introduction

The purpose of this study is twofold: (1) to construct and empirically estimate seasonal models for aggregate aircraft operations and (2) to generate 3-year forecasts (September 1977 to September 1980) from these models. The aggregates include: (1) air carrier operations, (2) air taxi operations, (3) general aviation local operations, and (4) general aviation intinerant operations.

The major modeling techniques used in this study include regression models with time series errors and parametric time series models.

For the regression models, a synthesis of the econometric approach and time series approach is employed to specify and estimate these models. The empirical results of these models can be used as a basis on which to evaluate the impacts of changes in certain macroeconomic variables on the behavior of aircraft operations. In addition, alternative forecasts can be generated from these models based on different scenarios of the future behavior of independent variables.

For the parametric time series models, autoregressive integrated moving average models (ARIMA) and intervention analysis models are used in modeling aircraft operations. The intervention analysis was applied to air carrier operations to take account of the strong effect of the energy crisis. These parametric time series models are used to generate monthly forecasts as well as quarterly forecasts. Further, these forecasts are employed as a norm of forecasts which can be compared with forecasts produced from corresponding regression models.

The major findings of this study can be summarized as follows:

(1) The empirical results of the regression model support the hypothesis that aggregate aircraft operations depend on general economic conditions, which are measured by real disposable income and undistributed corporate profits.

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(2) The energy crisis was found to have a statistically significant impact on air carrier operations. However, it was found to have less impact on air taxi operations.

(3) All aircraft operations exhibited strong seasonal variation with peak activity occurring either in the second or third quarter.

(4) Both regression models and parametric time series models explain the variations in aircraft operations reasonably well in the sample period studied.

(5) Quarterly and monthly forecasts from 1977:3 (September) to 1980:3 (September) have been produced and confidence intervals for the point forecasts are also constructed.

(6) Comparisons between forecasts generated from both types of models revealed the forecasting results to be generally consistent; thereby, reinforcing the reliability of the forecasting results.

The organization of this paper is composed of four sections. Section 2 presents our empirical model building methodologies, final regression models and quarterly forecasts generated from these models. The principle of parametric time series modeling is outlined and fitted time series models are presented in Section 3. Final discussions are presented in Section 4.

Regression Models with Time Series Errors

Some Considerations on Empirical Model Building

It is a difficult task to build and select alternative models based on nonexperimental data (i.e., observed data). This is because the variable of interest (the dependent variable) is influenced by many variables and/or interactions of these variables. Hence, ideally a very complicated model with a large set of parameters will be desired. However, the following factors limit the building of such a model: (1) the limited length of sample data, (2) the data availability of independent variables and (3) the increasing unreliability of the parameters as the number of parameters increase in the model. Hence, all models are wrong in the sense of not fully incorporating all variables found in reality. However, an empirical model is considered adequate if it can successfully serve the purpose for which it was intended. The empirical model serves two purposes in this study: (1) to aid in a better understanding of the nature of the mechanism generating this process and (2) to provide a partial prediction of the various outputs Y_t from various values of the input variables X_t's in the presence of unknown disturbances in the post-sample period.

Symbolically, the empirical model is stated as:

$$Y_t = f(X_t\text{'s} \mid \beta) + U_t \text{ and } U_t = \frac{1}{\rho(B)} e_t \qquad (1)$$
$$\rho(B) = (1 - \rho_1 B - \rho_2 B^2, \cdots, \rho_p B^p)$$

and B is a backward shift operator.

The part $f(X_t\text{'s} \mid \beta)$ is a predictable component, which contains the observed values of the X's and the associated unknown parameters β. U_t is considered as a catch-all variable which can be represented by a stationary parametric time series model such as a p^{th} order autoregressive process $U_t = \frac{1}{\rho(B)} e_t$. The notation e_t represents a sequence of independent normal random variables with zero mean and constant variance $\sigma^2_{e_t}$. The modeling of the error structure of U_t can be thought of as an approximation of the systematic effect of the omitted variables on the output series Y_t. Certainly, predictive accuracy will be improved if all possible systematic elements in the output series are extracted. For this reason, special attention was paid to modeling the error structure U_t.

Our modeling process can be summarized as follows:

(1) Based on aviation and economic considerations and the availability of data, all possible independent variables were experimented with in the model. This type of model is referred to as a "full model."

(2) According to the initial empirical results, the variables which are not statistically significant are deleted. The subsets of the full model are called reduced models.

(3) An analysis of the residuals from a reduced model was conducted. The analysis of residuals provides the following useful information: (1) some ideas of the homogeneity of variance, (2) some sort of normality of errors, (3) outlier identifications and replacement, (4) the appropriate degree of differencing in the model if U_t is a nonstationary time series and (5) information about misspecification of functional form of the equation.

(4) The model is considered as adequate if U_t is a "white noise" process; otherwise the error of U_t is modeled.[1] In this study, the following error structures of U_t were examined:

$$(1-\rho B)\, U_t = e_t$$
$$(1-\sum_{i=1}^{4} \rho_i B^i) U_t = e_t \qquad (2)$$
$$(1-\rho_4 B^4)\, U_t = e_t$$
$$(1-\rho_1 B - \rho_4 B^4 - \rho_5 B^5)\, U_t = e_t$$

In summary, a synthesis of econometric and time series modeling approach is adopted in this study.

[1] A random variable e_t is called a white noise process if it is normally independently distributed with zero mean and constant variance $\sigma^2_{e_t}$.

The Empirical Results

The time series data used in this study was obtained by the temporal aggregation of daily aircraft operation data collected by FAA towered airports. The daily time series data for air carrier operations, air taxi operations, general aviation (GA) local and GA itinerant operations were taken from FAA Form 7230-1, *Airport Traffic Record,* from January 1972 to 1977.

The final empirical models for these four aircraft operations are presented in Table C-1. The final models were chosen according to the following criteria: (1) the signs of the regression coefficients, (2) the statistical significance of the estimated coefficients, (3) the minimum mean square errors among competing models and (4) the lack of autocorrelations in the estimated residuals.

The definitions of variables used in Table C-1 are defined as:

Y_{1t} = Air carrier operations (measured in 1000 units)

Y_{2t} = Air taxi operations (measured in 1000 units)

Y_{3t} = General aviation itinerant operations (measured in 1000 units)

Y_{4t} = General aviation local operations (measured in 1000 units)

$I_1 = \begin{cases} 1 & 1972{:}1 \le t < 1973{:}4 \\ 0 & \text{otherwise} \end{cases}$

$I_2 = \begin{cases} 1 & t \ge 1973{:}4 \\ 0 & \text{otherwise} \end{cases}$

$X_{2t} = \begin{cases} \text{Real disposable income in 72 dollars} & 1972{:}1 \le t < 1973{:}4 \\ 0 & \text{otherwise} \end{cases}$

$X_{3t} = \begin{cases} \text{Real disposable income in 72 dollars} & t \le 1973{:}4 \\ 0 & \text{otherwise} \end{cases}$

X_{4t} = A dummy variable for the air strike which occurred 1975:4

X_{5t} = Real disposable income in 72 dollars

X_{6t-1} = Undistributed corporate profits lagged one period

$X_{7t} = \begin{cases} 1 & 1973{:}4 \le t \le 1974{:}1 \\ 0 & \text{otherwise} \end{cases}$

This is a dummy variable to approximate the oil embargo effects.

D_{it}, i = 1, 2, 3, 4 are seasonal dummy variables with the restriction that

$$\sum_{i=1}^{4} \delta_i = 0$$

where δ_i is the coefficient of D_{it}.

This implies:

$$D_{it} = \begin{cases} 1 & \text{if observation t occurs in quarter i} \\ -1 & \text{if observation t occurs in quarter 4} \\ 0 & \text{otherwise} \end{cases}$$

Table C-1 Regression Models and Related Statistics Quarterly Data 1972:1 to 1977:3

Air Carrier

$$Y_{1t} = \underset{(1.837)}{854.39\, I_1} + \underset{(3.44)}{1.945\, X_{2t}} + \underset{(3.25)}{993.03\, I_2} + \underset{(4.53)}{1.579\, X_{3t}} \quad (3)$$
$$\underset{(-2.16)}{-102.337\, X_{4t}} \underset{(-1.55)}{-25.033\, D_1} \underset{(-0.28)}{-4.191\, D_2} + \underset{(3.95)}{59.94\, D_3}$$

SER = 41.79 R^2 –.867 D-W Statistic = 1.68

Method of Estimation: Ordinary Least Squares (OLS)

Air Taxi

$$\log Y_{2t} = \underset{(-2.43)}{-8.55} + \underset{(4.23)}{2.141 \log X_{5t}} + \underset{(3.18)}{0.155 \log X_{6t-1}} \quad (4)$$
$$+ \underset{(0.22)}{0.006\, X_{7t}} \underset{(-5.49)}{-0.0444\, D_1} + \underset{(1.15)}{0.008\, D_2} + \underset{(8.42)}{0.659\, D_3}$$

The error structure: $(1-1.43B + 0.579B^2)\,\hat{U}_t = e_t$

SER = 0.033 R^2 = 0.87 D-W Statistic = 2.4

Method of Estimation: Generalized Least Squares

General Aviation Itinerant Operations

$$\log Y_{3t} = 0.462 + \underset{(0.164)}{1.168 \log X_{5t}} + \underset{(2.809)}{0.0942 \log X_{6t-1}} \quad (5)$$
$$\underset{(2.211)}{} \underset{(-0.233)}{-0.0068\, X_{7t}} \underset{(-12.17)}{-0.1104\, D_1} + \underset{(8.372)}{0.0749\, D_2} + \underset{(11.729)}{0.104\, D_3}$$

The error structure: $(1-0.894B)\,\hat{U}_t = e_t$

SER = 0.034 R^2 = 0.95 D-W Statistic = 2.06

Method of Estimation: Generalized Least Squares

General Aviation Local Operations

$$\log Y_{4t} = \underset{(-1.54)}{-2.735} + \underset{(6.32)}{1.667 \log X_{5t}} \underset{(-0.748)}{-0.024\, X_{7t}} \underset{(-9.5)}{-0.1076\, D_1}$$
$$+ \underset{(9.18)}{0.1013\, D_2} + \underset{(8.21)}{0.092\, D_3} \quad (6)$$

The error structure: $(1-0.475B)\,\hat{U}_t = e_t$

SER = 0.036 R^2 = 0.95 D-W Statistic = 1.86

Method of Estimation: Generalized Least Squares

The notation of SER represents the standard deviation of estimated residuals and D-W Statistic represents Durbin-Watson Statistic which is designed to test for the presence of first order autoregressive process in the error terms of the static single equation regression model. Of course, the rejection of the null hypothesis of the D-W Statistic can only imply the lack of a first order autoregressive process in the error terms. Hence, in the modeling process, we have considered alternative types of autoregressive processes [See (2)] and the autocorrelations of the estimated errors are computed to check for the lack of autocorrelations in the residuals.

The dummy variable approach is used to take account of the seasonality in aircraft operations in the regression model. Inclusion of the seasonal dummy in the model is used to represent a fixed seasonality. The changing seasonality is approximated by $D_{it}t$ $i = 1, 2, 3$, and t is a linear trend. However, none of the coefficients of $D_{it}t$ are statistically significant. Hence, the fixed seasonal dummy $D_{it}i = 1, 2, 3$ is considered reasonable to represent the seasonal components of the series.

The numbers in parentheses are the associated t-statistics of the coefficients. In the air carrier equation (3), the estimated coefficients are statistically significant at the 1 percent level. Further, the signs of the coefficients are consistent with prior expectations. To take account of the intervention of the oil embargo, a Chow test on the change in parameter values of the regression model was performed and the result suggested that the parameters of the intercepts and YD in 72 dollars had a statistically significant change. This led to the formation of equation (3).

From equation (4), it can be seen that air taxi operations is a function of real disposable income in 72 dollars, undistributed corporate profits lagged one period and seasonal dummies. Real disposable income is used to explain the variations in operations due to personal trips, while undistributed corporate profits lagged one period is used to explain the change in operations due to business trips. The empirical results support the hypothesis that air taxi operations increase as real disposable income and/or undistributed corporate profits increase. It is interesting to observe that the coefficient for the energy crisis X_{7t} in equation (4) is positive but not statistically significant. One of the possible explanations for this fact is that during the energy crisis, the substantial decrease in air carrier operations might have caused a substitution effect away from air carriers to air taxi. Strong seasonality is present in air taxi operations with operations peaking in the third quarter.

The empirical equation for general aviation itinerant operations is reported in (5). The coefficients of real disposable income and undistributed corporate profits are both positive and statistically significant at the 1 percent level. These results indicate that general aviation itinerant operations increases as either or both of these variables increase.

The variable for undistributed corporate profits was found to be statistically insignificant in the initial equation of general aviation local operations. This is expected because the major determinants of local operations are the number of student pilots and the number of licensed pilots. These variables, in turn, depend on general business activity. The empirical results in equation (6) are consistent with this hypothesis that the coefficient of real disposable personal income is positive and statistically significant at the 1 percent level.

In terms of seasonality, both types of operations are busiest in the third quarter, followed by second, fourth and first quarters, respectively. The peaking of GA operations in the third quarter is due to the improved weather conditions in the third quarter and the popularity of the summer months for vacationing.

In examining the error structure of the above equations, it was found that the systematic elements left in the residuals could be modeled by a parametric time series structure. In particular, air taxi was found to have a second order autoregressive process, while both general aviation itinerant and local operations were found to follow a first order autoregressive process. These findings lend support to the argument that the errors of a model estimated by time series data are often autocorrelated.

Forecasting

Our forecasts assume implicitly that the basic structure of the equations will remain unchanged through 1981. The future values of the exogenous variables were obtained from quarterly forecasts produced by Data Resources, Inc. The best linear unbiased prediction for the regression model with a p^{th} order autoregressive process of the error terms is computed as follows:

$$Y_t = \hat{\beta}_0\left(1-\sum_{i=1}^{P} \hat{\rho}_i\right) + \sum_{j=1}^{k}\hat{\beta}_j\left(X_{jt}-\sum_{i=1}^{P}\hat{\rho}_i X_{jt-i}\right) + \sum_{i=1}^{P}\hat{\rho}_i Y_{t-i}$$

where $\hat{\rho}_i$, $i = 1, 2, \ldots p$ are the estimated coefficients of the p^{th} order autoregressive process of the error terms and $\hat{\beta}_j$, $j = 1, 2 \ldots k$ are the estimated regression coefficients.

The indicator approach suggested by Fuller[2] is used to compute the estimated standard error of the forecasts for the regression model with general covariance structure.

Following the general procedure, quarterly forecasts and corresponding 75 percent confidence intervals for forecasts are reported in Tables C-2 to C-5. The performance of the equations and their corresponding forecasts are displayed in Figures C-1 to C-4.

[2]See Fuller, A. A., *Introduction to Statistical Time Series*, John Wiley and Sons, 1976, pp. 449-450.

Table C-2 Quarterly Forecast of Air Carrier Operations*

Year	Quarter	Lower Limit	Point Estimate	Upper Limit
1977	4	2399.57	2493.04	2586.31
1978	1	2394.53	2467.01	2539.49
	2	2438.62	2505.87	2575.12
	3	2528.52	2598.10	2667.68
	4	2472.73	2516.96	2621.15
1979	1	2454.81	2536.07	2618.53
	2	2488.14	2569.06	2669.96
	3	2563.70	2644.28	2724.86
	4	2503.23	2594.85	2686.47
1980	1	2501.64	2593.03	2664.54
	2	2538.02	2630.05	2723.04
	3	2620.54	2712.04	2803.62

Table C-3 Quarterly Forecast of Air Taxi Operations*

Year	Quarter	Lower Limit	Point Estimate	Upper Limit
1977	4	845.97	887.75	931.60
1978	1	793.87	863.10	938.40
	2	876.40	928.60	1040.90
	3	879.40	1015.20	1172.00
	4	800.00	949.70	1110.80
1979	1	777.11	931.26	1116.00
	2	823.80	995.30	1202.70
	3	877.90	1070.95	1306.40
	4	814.40	999.10	1225.70
1980	1	813.90	1010.50	1254.60
	2	880.00	1097.95	1369.90
	3	950.30	1195.89	1505.00

Table C-4 Quarterly Forecasts of GA Local Operations*

Year	Quarter	Lower Limit	Point Estimate	Upper Limit
1977	4	5299.99	5584.71	5884.7
1978	1	5068.89	5376.80	5703.3
	2	6335.70	6742.20	7174.7
	3	6427.20	6878.40	7361.3
	4	5447.50	5857.98	6299.4
1979	1	5357.30	5771.10	6216.8
	2	6683.20	7200.60	7758.2
	3	6682.70	7217.20	7794.4
	4	5675.98	6158.20	6681.3
1980	1	5624.00	6120.80	6661.6
	2	7043.54	7674.20	8361.2
	3	7076.21	7736.10	8461.8

Table C-5 Quarterly Forecast of GA Itinerant Operations*

Year	Quarter	Lower Limit	Point Estimate	Upper Limit
1977	4	6509.42	6819.29	7143.9
1978	1	6109.60	6489.68	6893.4
	2	7377.40	7914.63	8491.0
	3	7662.30	8318.50	9030.9
	4	6477.40	7107.89	7799.7
1979	1	6179.60	6836.54	7563.4
	2	7469.50	8297.39	9217.1
	3	7710.50	8622.12	9641.6
	4	6531.20	8359.87	8293.6
1980	1	6289.60	7151.79	8132.1
	2	7654.40	8741.32	9982.6
	3	7933.50	9130.72	10508.6

*75% Confidence Interval

Figure C-1 Quarterly Forecasts for Air Carrier Operations

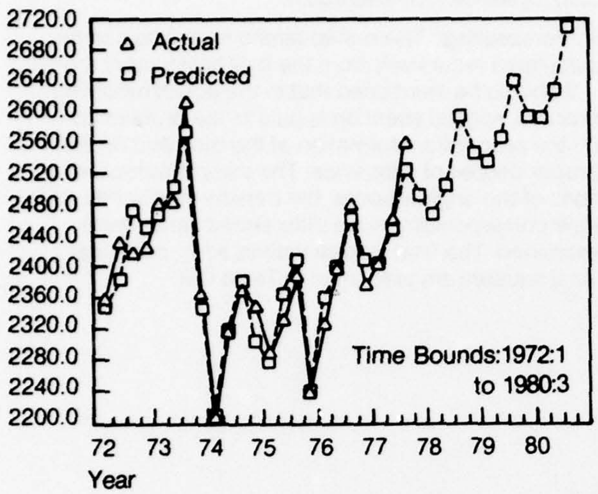


Figure C-2 Quarterly Forecasts for Air Taxi Operations

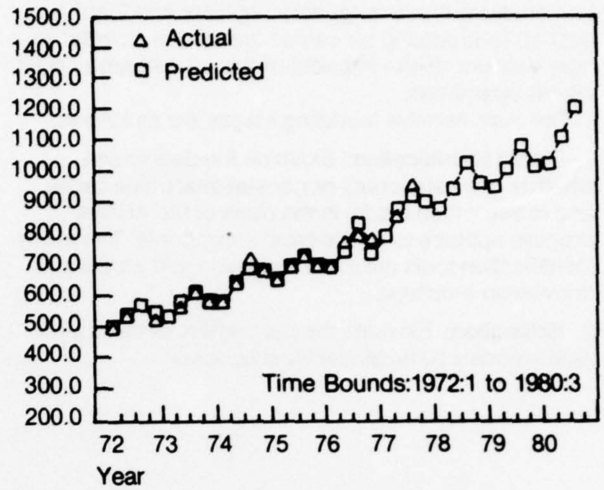


Figure C-3 Quarterly Forecasts for General Aviation Local Operations

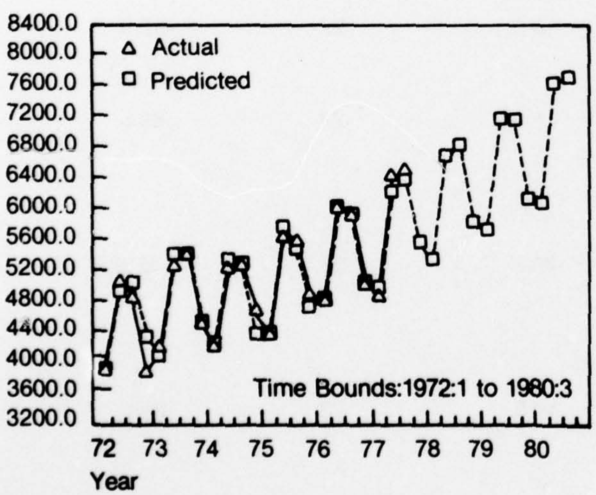
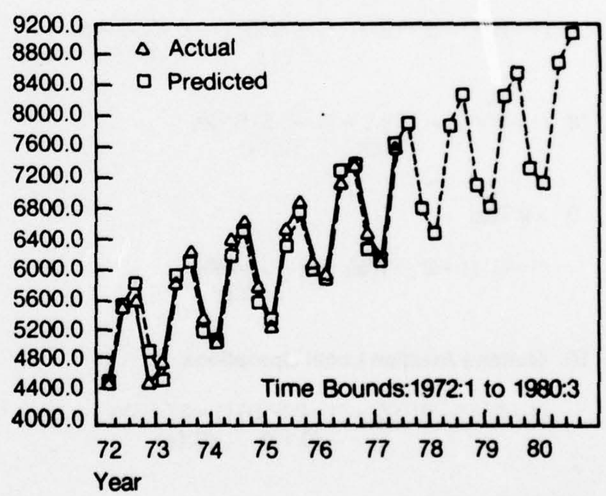


Figure C-4 Quarterly Forecasts for General Aviation Itinerant Operations



Parametric Time Series Models

Autoregressive Integrated Moving Average (ARIMA) models were fitted for GA itinerant operations, GA local operations and air taxi operations. An intervention analysis model suggested by Box and Tiao[3] is applied to modeling air carrier operations in order to take account of the impacts of the oil embargo on air carrier operations.

The main iterative modeling stages are as follows:

1. **Model Identification:** Examine the data to see whether it is a stationary or nonstationary time series and to see which model in the class of the ARIMA process appears to be the most appropriate. The major identification tools are autocorrelation and partial autocorrelation functions.

2. **Estimation:** Estimate the parameters of the appropriate models by nonlinear least squares.

3. **Diagnostic Checking:** The estimated model is considered adequate if the residuals from the estimated model can be considered as white noise. Otherwise, alternative models will be considered and step (1) and step (3) will be repeated again:

4. **Forecasting:** The *n*-step-ahead forecasts can be calculated recursively from the final satisfactory model.

It should be mentioned that in the actual modeling process, special attention is paid to the problem of: (1) the proper transformation of the data and (2) the proper degree of difference. The sample autocorrelations of the original series, the transformed series and their corresponding three differenced series were examined. The final models estimated by nonlinear least squares are presented in Table C-6.

Table C-6 Fitted Time Series Models Monthly Data (1972:1 to 1977:9)

ARIMA Models	Test of Residuals Q	D.F.	Estimated Standard Errors
7. **General Aviation Itinerant Operations**			
$(1-B)(1-B^{12})Z_t = \underset{(0.31)}{(1-0.95B)}\underset{(0.15)}{(1-0.455B^{12})}e_t$	18.0	22	92.9
**8. $(1-B^{12})Z_t = \underset{(7.39)}{139.1} + \underset{(0.14)}{(1-0.51B^{12})}e_t$	18.9	22	89.5
9. **Air Taxi**			
$(1-B)(1-B^{12})\ln Z_t = \underset{(0.13)}{(1-0.349B)}e_t$	25.2	23	0.037
10. **General Aviation Local Operations**			
$(1-B)(1-B^{12})Z_t = \underset{(0.12)}{(1-0.55B)}\underset{(0.14)}{(1-0.55B)}e_t$	10.3	22	88.0
11. **Air Carriers**			
$Z_t = \underset{(12.86)}{-41.95}\,\xi_t^* + \dfrac{\underset{(0.13)}{(1-0.662B^{12})}}{(1-B)\underset{(0.038)}{(1-0.96B^{12})}}e_t$	8.5	22	19.09

**Forecasts were generated from this equation.

$^*\xi_t$ is an indicator variable which denotes 1 for Nov. 1973 to March 1974, zero otherwise.

Two tests were performed on the autocorrelation of the estimated residuals from each model. First, individual autocorrelations were compared to their respective standard errors; second, the test statistics

$$Q = \frac{1}{N} \sum_{K=1}^{J} \hat{\gamma}^2(K)$$

were calculated. $\hat{\gamma}(K)$ is the Kth order autocorrelation of the residuals from the fitted model; J, the number of autocorrelations computed; and N, the sample size of residuals. Then a joint overall test was performed and the residuals were compared to the χ^2 statistics at a 5 percent level of significance, with J-P degrees of freedom (DF), P is the number of parameters estimated in the model. Examination of the test results suggests that each fitted model is adequate because the test results failed to reject the null hypothesis that the error term e_t is distributed as a white noise process.

Monthly forecasts for these aircraft operations are generated from equations (8) (9) (10) and (11), respectively. Upon examination of the forecasts generated from the time series models and the corresponding regression models, it was found that the forecasts generated from these two procedures are in general consistent with each other in the sense that the point forecasts of one procedure lies entirely in the forecasting intervals of another procedure. This result provides increasing confidence that the forecasts are reliable. Table C-7 presents a summary of annual forecasts for Fiscal Years 1978 through 1980. It is apparent that all forecasts are generally consistent with one another, with the FAA forecasts falling within the calculated confidence intervals.

Final Discussions

In this study, it has been demonstrated that both the empirical econometric modeling approach and the time series modeling approach are appropriate for modeling the seasonal behavior of aggregate aircraft operations at FAA towered airports. The empirical results of the econometric models indicate that the level of aggregate aircraft operations depend on general economic conditions.

Univariate time series models are adopted in this study for short-term forecasting purposes. This approach is complementary to the econometric modeling approach. The time series analysis results are employed as a norm for forecasts which can be compared with the forecasts generated from econometric models. Futhermore, time series analysis is very useful in a limited information situation where the data for the independent variables are unavailable. For example, parametric time series models are very useful techniques in modeling and forecasting aircraft operations both on a regional and individual airport basis.

These models and forecasts will be updated as new observations become available and the quality of the forecasts from both types of models will be evaluated. The building of a working forecasting system is an iterative process—it requires time to test the predictive ability of the models. Subsequent modifications will be made on the specification of the models to incorporate new information (or new events) into the model; this information being unavailable at the time of the forecasts.

Table C-7 Comparison of Forecasts from Regression Models, Time Series Models and FAA Preliminary Forecasts

		Regression Model Forecasts			Time Series Model Forecast			FAA Forecast
	Fiscal Year	Lower Limit	Point Forecast	Upper Limit	Lower Limit	Point Forecast	Upper Limit	Point Forecast*
Air Carrier	1978	9759.24	10064.02	10368.80	9456.80	10096.20	10735.60	10100.00
	1979	9979.38	10296.95	10614.52	9050.83	10298.60	11546.37	10400.00
	1980	10205.47	10530.47	10862.47	8669.20	10493.60	12318.00	10600.00
Air Taxi	1978	3347.64	3694.65	4082.90	3623.91	3917.95	4237.23	3600.00
	1979	3278.61	3947.21	4735.90	3893.08	4666.91	5996.69	4100.00
	1980	3458.60	4303.44	5355.20	4054.40	5559.10	7634.24	4500.00
General Aviation Local	1978	23131.78	24582.11	26124.00	21135.49	22866.51	24597.52	24700.00
	1979	24170.70	26046.88	28068.80	20771.79	23851.79	26931.78	26600.00
	1980	25419.73	27691.30	30165.90	18445.89	24836.93	29471.97	27700.00
General Aviation Local	1978	27658.72	29542.10	31559.20	28609.33	29844.51	31079.70	30400.00
	1979	27837.00	30863.94	34221.80	30137.98	31513.71	32889.44	32600.00
	1980	28408.70	32383.70	36916.90	31679.71	33182.91	34686.11	34400.00

*FAA Forecasts are obtained from U. S. Dept. of Transportation, *Preliminary Aviation Forecasts*, March, 1978.

[3] Box, G. P. and G. C. Tiao, "Intervention Analysis with Applications to Economic and Environmental Problems" *Journal of the American Statistical Association* (1975), Vol. 70 pp. 70-79.

Glossary of Terms

Aerial Application Aerial application in agriculture consists of those activities that involve the discharge of materials from aircraft in flight and a miscellaneous collection of minor related activities that do not require the distribution of any materials.

Aircraft Contacted Aircraft with which the Flight Service Stations have established radio communications contact. One count is made for each enroute, landing or departing aircraft contacted by Flight Service Station regardless of the number of contacts made with an individual aircraft during the same flight.

Aircraft Operation An aircraft arrival at or departure from an airport with FAA airport traffic control service. There are two types of operations—local and itinerant.

1. Local operations are performed by aircraft which:
   (a) Operate in the local traffic pattern or within sight of the tower.
   (b) Are known to be departing for, or arriving from, flight in local practice areas located within a 20-mile radius of the control tower.
   (c) Execute simulated instrument approaches or low passes at the airport.
2. Itinerant Operations:
   All aircraft arrivals and departures other than local operations.

Airport Traffic Control Tower A central operations facility in the terminal air traffic control system, consisting of a tower cab structure, including an associated IFR room if radar equipped, using air/ground communications and/or radar, visual signaling and other devices, to provide safe and expeditious movement of terminal air traffic.

Air Route Traffic Control Center A central operations facility in the air route traffic control system using air/ground communications and radar, primarily providing enroute separation and safe, expeditious movement of aircraft operating under instrument flight rules within the controlled airspace of that center.

Air Taxi Operations Air taxi operations and commuter air carrier operations (takeoffs and landings) carrying passengers, mail or cargo for revenue in accordance with FAR Part 135 or Part 121.

Air Taxi Operators Operators of small aircraft "for hire" for specific trips. They operate under CAB Part 298 and FAR 135 which apply to aircraft of 12,500 pounds or less except under special exemption.

Air Traffic Hub Air traffic hubs are not airports; they are the cities and Standard Metropolitan Statistical Areas requiring aviation services and may include more than one airport. Communities fall into four classes as determined by each community's percentage of the total enplaned passengers.

Large: 1.00% (2,071,729 passengers and over in FY 1976)

Medium: 0.25% to 0.99% (Between 517, 932 and 2,071,728 passengers in FY 1976)

Small: 0.05% to 0.24% (Between 103,586 and 517,931 passengers in FY 1976)

Nonhub: Less than 0.5% (under 103,585 passengers in FY 1976)

All-Cargo Carrier One of a class of air carriers holding certificates of public convenience and necessity issued by the CAB, authorizing the performance of scheduled air freight, express, and mail transportation over specified routes, as well as the conduct of nonscheduled operations, which may include passengers.

Approach Control Facility A terminal air traffic control facility providing approach control service.

Available Seat-Miles The aircraft miles flown in each flight stage multiplied by the number of seats available on that stage length for revenue passenger use.

Business Transportation Any use of an aircraft not for compensation or hire by an individual for the purposes of transportation required by a business in which he is engaged.

Certificated Route Air Carrier An air carrier holding a certificate of public convenience and necessity issued by the Civil Aeronautics Board to conduct scheduled services over specified routes. Certain nonscheduled, or charter operations may also be conducted by these carriers.

Common IFR Room A highly automated terminal radar control facility. It provides terminal radar service in an area encompassing more than one major airport which accommodates instrument flight operations.

Commuter Operator Operators of small aircraft of a maximum size of 30 seats and a 7,500 pound payload, who perform at least five scheduled round trips per week between two or more points or carry mail. They operate under CAB Part 298, FAR 135, and at times FAR 121.

Contract Operator An air carrier operating on a private for-hire basis, as distinguished from a public or common air carrier, holding a commercial operator certificate (issued by the FAA under FAR 121) authorizing the carrier to operate aircraft over 12,500 pounds for the transportation of goods or passengers for compensation or hire.

Domestic Trunk Carriers One of a group of certificated route air carriers which operates primarily within and between the 50 States of the United States and the District of Columbia over routes serving primarily the larger communities.

Executive Transportation Any use of an aircraft by a corporation, company or other organization for the purposes of transporting its employees and/or property not for compensation or hire and employing professional pilots for the operation of the aircraft.

FAA Flight Plan Specified information relating to the intended flight of an aircraft, that is filed orally or in writing with a flight service station or an air traffic control facility.

Flight Service Station (FSS) Air Traffic Service facilities within the National Aviation System which provide preflight pilot briefing and enroute communications with VFR flights, assist lost IFR/VFR aircraft, assist aircraft having emergencies, relay ATC clearances, originate, classify, and disseminate Notices to Airmen, broadcast aviation weather and

NAS information, receive and close flight plans, monitor radio NAVAIDS, notify search and rescue units of missing VFR aircraft, and operate the national weather teletypewriter systems. In addition, at selected locations, FSSs take weather observations, issue airport advisories, administer airman written examinations, and advise Customs and Immigration of transborder flight.

Foreign-Flag Air Carrier An air carrier other than a U.S. flag air carrier in international air transportation. "Foreign air carrier" is a more inclusive term than "foreign-flag air carrier," presumable including those non-U.S. air carriers operating solely within their own domestic boundaries, but in practice the two terms are used interchangeably.

General Aviation All civil aviation activity except that of certificated route air carriers and air commuter operations. The types of aircraft used in general aviation (GA) activities cover a wide spectrum from corporate multiengine jet aircraft piloted by professional crews to amateur-built single-engine piston acrobatic planes, balloons and dirigibles.

IFR Aircraft Handled The number of IFR departures multiplied by two plus the number of IFR overs. This definition assumes that the number of departures (acceptances, extensions, and originations of IFR flight plans) is equal to the number of landings (IFR flight plans closed).

Industrial/Special Flying Any use of an aircraft for specialized work allied with industrial activity; excluding transportation and aerial application. (Examples: pipeline patrol; survey; advertising; photography; helicopter hoist; etc.)

International and Territorial Operations Operators of aircraft flying between the 50 States of the United States and foreign points, between the 50 States and U.S. possessions or territories, and between foreign points. Includes both the combination passenger/cargo carriers and the all-cargo carriers engaged in international and territorial operations.

Intrastate Air Carrier A carrier licensed by a state to operate wholly within its borders but not permitted to carry interline passengers from out of state. They are not regulated by the CAB.

Instructional Flying Any use of an aircraft for the purposes of formal instruction with the flight instructor aboard or with the maneuvers on the particular flight(s) specified by the flight instructor.

Instrument Operation An aircraft operation in accordance with an IFR flight plan or an operation where IFR separation between aircraft is provided by a terminal control facility or air route traffic control center.

Local Service Carriers Certificated domestic route air carriers operating routes of lesser density between the smaller traffic centers and between those centers and principal centers.

Other Use Flying Use of general aviation aircraft for purposes other than those in specific categories, such as business, personal, air taxi.

Personal and Pleasure Flying Any use of an aircraft for personal purposes not associated with a business or profession, and not for hire. This includes maintenance of pilot proficiency.

Pilot Briefing A service provided by the Flight Service Station to assist pilots in flight planning. Briefing items may include weather information, NOTAMS, military activities, flow control information and other items as requested.

RAPCON Radar Approach Control Facility (Air Force).

RATCF Radar Approach Control Facility (Navy).

Registered Active General Aviation Aircraft A civil aircraft registered with the FAA that has been flown one or more hours during the previous calendar year. Excluded are aircraft owned and operated in regularly scheduled, nonscheduled, or charter service by an air carrier certificated by the Civil Aeronautics Board or aircraft in excess of 12,500 pounds maximum gross takeoff weight owned and operated by a commercial operator certificated by the FAA to engage in intrastate common carriage.

Revenue Passenger Enplanements The count of the total number of passengers boarding aircraft. This includes both originating and connecting passengers.

Revenue Passenger Load Factor Revenue passenger-miles as a percent of available seat-miles in revenue passenger services, representing the proportion of aircraft seating capacity that is actually sold and utilized.

Revenue Passenger Mile One revenue passenger transported one mile in revenue service.

Revenue Ton-Mile One ton of revenue traffic transported one mile.

Secondary Airport An airport receiving approach control service as a satellite to a primary approach control facility, or one at which control is exercised by the approach control facility under tower enroute control procedures.

Supplemental Air Carrier One of a class of air carriers holding certificates, issued by the CAB, authorizing them to perform passenger and cargo charter services supplementing the scheduled service of the certificated route air carriers. They are sometimes referred to as nonscheduled carriers.

Total Flight Services The sum of flight plans originated and pilot briefs, multiplied by two, plus the number of aircraft contacted.

U.S.-Flag Carrier or American-Flag Carrier One of a class of air carriers holding a certificate of public convenience and necessity issued by the CAB, approved by the President, authorizing scheduled operations over specified routes between the United States (and/or its territories) and one or more foreign countries.

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